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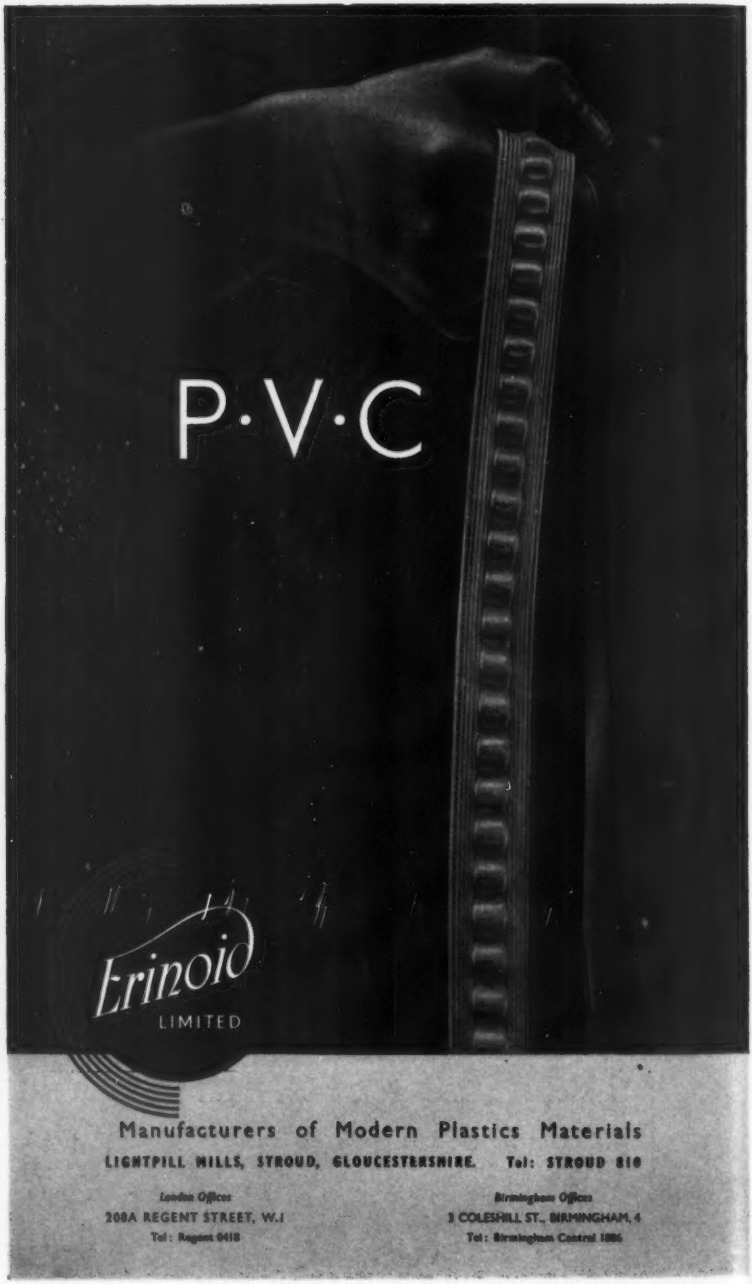
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Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

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NOTICES

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EDITORIALS

Raw Materials for the Plastics Industry

OUR editorial comment on the above subject has brought us a most interesting letter from the Forestal Land, Timber and Railways Co., Ltd., of Harpenden, Herts; it refers to our remarks concerning the lack of interest shown in the natural phenolic compounds that exist in certain vegetations. This company, it appears, has carried out a great deal of work on the subject of synthetic resins made from such sources, and, indeed, has produced moulding powders from them. This is certainly good news, although we must admit we were unaware of such activities, that is, work outside that of Holmes, Morgan and, we believe, Megson, at the Government Chemical Laboratory at Teddington.

We had already presumed that the available natural tannins which are the phenolics in question would, like everything else in this world, be in short supply and retained for the leather industry. It was for this reason that we advocated, as an extension of colonial development, the examination of the problem of quebracho and mimosa growing, especially since we have such concerns as the Forestal Land, Timber and Railways Co., with the requisite technical knowledge for the extraction of the tannins from plants. Mr. Rottsieper's admission that such plantations are absent in the Empire is surely an excellent reason for their creation.

On the important subject of alcohol which is so vital to our plastics industry, and which large-scale production we advocated from vegetable sources in the tropics, we were interested to read a recent paper by Dr. P. Schidrowitz given before the Institution of the Rubber Industry. Referring to possible improvements in the quality of natural rubber, he describes a new process which entails the use of large quantities of alcohol and says, "I suggest that for various reasons the large-scale production of industrial alcohol in the tropics be given consideration. It may well be that alcohol will prove to be one of the chief basic raw materials of the future, with certain advantages over acetylene, except where there is unlimited water-power. In this way, then, alcohol may well become of prime interest to the rubber producer (natural or synthetic), to the plastics industry and to the chemical industry on a much wider basis than hitherto." In view of the frightening shortage of world petroleum, we should add that the fuel industry would also be interested and be a buyer.

Some time ago we stated that for certain polymers made from ethylene, this ethylene is produced from alcohol, and lamented the fact that ethylene gas itself is not extracted directly from town's gas, which contains it in small quantities. We have now read a valuable paper by P. M. Schuftan ("Chemistry and Industry," February 14, 1948) on "A new process for the recovery of ethylene from coke-oven gas," which indicates that ethylene of 97 per cent. purity and higher can now be economically produced from any source of coke-oven gas of more than, say, 8,500,000 cubic ft. per day, and there are many such plants in this country. Commercially, such production would compare well with competitive processes, such as oil cracking, and ethylene thus becomes a possible raw material for the first time from indigenous products. This development is being carried out by the British Oxygen Co., Ltd., at Corby, and the ethylene so produced is being converted into ethyl alcohol. We hope that it is pure enough for direct conversion into polymers, such as polyethylene, and for the production of styrene and thence polystyrene, thus avoiding the normal use of alcohol.

Future of P.V.C.

An assessment of the place of plastics in the economic and technical structure of our world has been put forward ever since plastics were first introduced. According to most writers, biased for the most part, plastics have been put forward either as cutting entirely new avenues in industry or as replacements affecting adversely the existence of older industries.

The truth is that both statements are correct, and we need lose no sleep by accepting it. Of greater importance are technical evaluations by the unbiased, or at least near unbiased, and we now find such views expressed by the aforesaid Dr. Schidrowitz in the same paper named on the previous page. It would certainly appear that our prophecy of ten years ago, that the plastics and rubber industries will rapidly draw closer technically, must come to pass. Referring to weatherproof garments, leathercloth and floor coverings, the author states:

"It seems to me that in the long run p.v.c. and similar plastics will be of interest to the rubber manufacturer as a proofing material rather than in the form of the unsupported film. The latter may survive for certain special purposes, i.e., where the processing advantages and attractive appearance, coupled with specific qualities, such as resistance to seawater and to perishing, are particularly relevant. In this class are articles such as paddlers, baby knickers and the like, and the hardening to which the thermoplastics are liable in cold weather is not of any particular importance for such applications. On the other hand, the unsupported film garments which are so attractive in appearance are not likely, in my view, to replace rubber or oil-proofed garments to any substantial extent in the future, in view of their liability to hardening, cost and various minor processing difficulties.

"I think that as substitutes for leather there is a considerable future for plastics proofings, and to some minor extent the plastics may replace rubber in footwear, provided that the cost is not prohibitive. The most promising field for plastics as substitutes for leather is, in my view, in the leathercloth industry. In this regard, for example, p.v.c. seems to have definite advantages over the conventional nitrocellulose coatings and also over rubber proofings.

"Floor coverings containing plastics have also been advocated, and I am inclined to think that their use in conjunction with rubber has distinct possibilities in the future. Having regard to particulars which have been published as to the properties of specific mixings of certain plastics with synthetic rubber, some plastics may prove to be the missing link required in the production of the so-called 'rubber linoleum.'"

The writer's remarks regarding "leathercloth" are very interesting. It has always seemed strange to us that the rubber-proofers have not to any important extent interested themselves in this branch, which has been evolved largely by the textile and plastics industry and is growing rapidly and surely.

Brush Backs

WE have received from the Ferguson Radio Corporation, Ltd., a letter which, for reasons which will hereafter appear, we prefer to discuss in these columns instead of relegating it to our "Letters to the Editor" page.

It is a request for our assistance in finding "a source of supply of Bakelite moulded brushes. These would be required for vacuum cleaners, i.e., round, oval, etc., incorporating the socket and brush back, which replaces the existing type with wooden back and die-cast socket. Your comments on this subject would be greatly appreciated....." We can take it for granted that the word "Bakelite" is used here in a general sense to mean the phenolic resins which result in a hard-moulded shape.

This letter is most opportune, for it gives us the chance of ventilating a matter very close to our own heart and perhaps closer still to the delicate hearts of long-suffering housewives throughout

the country. With these solemn words we may now proceed with our comments.

Whether the problem is one of shortage of wood and metal or not, we consider their replacement in whole or part by phenolic resins a feasible and a reasonable one, if the hard structure normally used is required. If the wood-filled phenolic type is not considered robust enough, then there are many fabric and similarly filled types with very high impact strengths which would prove suitable for withstanding "bad treatment." Alternatively, laminated resin-impregnated structures which can be machined are also available.

But, and here we wish to draw the attention of all vacuum cleaner manufacturers, we consider that too much emphasis has been laid on the brush-back itself, the "ideal" presumably being to manufacture so that it should last "for ever," which is not a bad thing; therefore it is argued it should be of wood, that is cheap, strong and hard. But need it be hard and need we think only of cruelty to brush-backs in making a decision? Should we not also think of the effect of the hard brush-back on our furniture? Let us take the reader to our own and only slightly hypothetical home.

Around the edges of the floor of our spacious and elegant salon we note sticking out several inches, at inconvenient places, a number of light switches and power points. Here and there in rich profusion are several early Victorian whatnots, a lovely Chinese Caledon vase with Gladstone's picture on it, a lady's four-legged work-table (Aunt Emily's wedding present), a nest of serving tables, bookcases and precious antiques gleaned from the Farringdon Road market and many a Tottenham Court Road warehouse. The secret collections of years, originally costing £120, we should be ashamed now to ask more than £700.

Why? You may well ask. Because most of the switches and power points are broken, Aunt Emily's present is a drunken travesty of its former greatness with one leg askew, Gladstone's nose is broken and has to be turned to the wall, and the mottled green paint on the mahogany bookcases is chipped exposing the white wood beneath.

And again, why? Because, dear readers, of the wooden brush back wielded by a ferocious char-lady (we beg her pardon, lady-help) anxious to justify her half a-crown an hour and even more anxious to run off to the cinema. Do you wonder why we do not want a wooden brush-back —or even a hard synthetic moulded one?

Why not let us have a softish yet tough one, one that would be kind to dumb furniture? Let it be of moulded p.v.c., or polythene or rubber. These materials can be moulded and a few samples for experiment could easily be made out of p.v.c. cement or cut from block polythene. Price would be higher than wood, but what would a little increase matter in comparison to the advantages and appeal to the housewife?

Alternatively, you can insist on your "Bakelite," but please put a thick band of p.v.c. or polythene round it.

S.O.S.

A WIMPOLE STREET medical friend of ours, who specialized some three or fours years ago in jumping from aeroplanes into places like Arnhem in order to succour the wounded, now specializes in less ferocious exploits such as children's ailments. Witness an S.O.S. we have received from him in which he asks the name of the makers, presumed to be in Devon, of the amusing carved animal in the accompanying photograph. He says that such objects are of immense use to him in dealing with his little patients.

So will the manufacturers or distributors please get into touch with us, so that we can spread the good news?

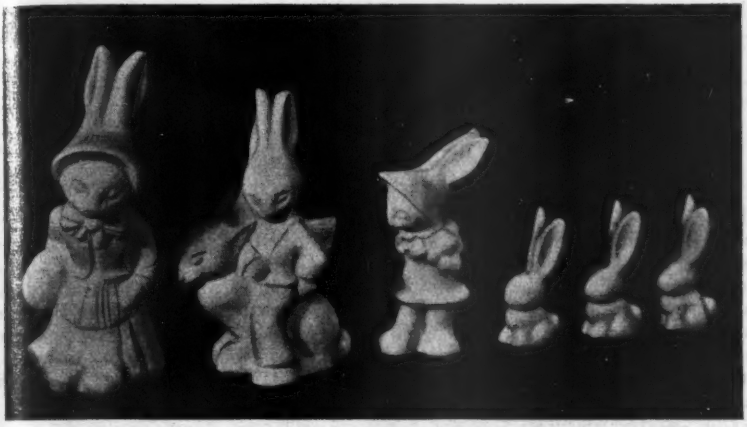


Fig. 1.—A group of plaster casts made in flexible moulds of the type here described.

FLEXIBLE MOULDS FROM VINYL COMPOUNDS

by Dr. H. Reichard*

A SERIES of elastomers known as "Vinamolds"† has been developed as mould-forming materials of a highly flexible nature for plaster-of-Paris, cast resins and cement. They were developed and are now manufactured by Vinyl Products, Ltd. They replace the conventional gelatine as at present used in the plaster-casting industry. They are thermoplastic, recoverable, completely water-resistant and do not dry out and shrink as does gelatine.

In the case of cast resins and cement, the Vinamolds are probably unique, it being believed no easily reclaimable, flexible, and thermoplastic material has existed up to now which would permit the production of castings from these materials.

The compounds are based on a vinyl resin and can be melted down to a liquid to be poured around a model to form a flexible mould. Their tensile strength and flexibility are such as to allow objects with deep undercuts to be removed from the mould without damage. This permits of the production of a wide range of objects in one-piece moulds which by the conventional technique would have required multiple moulds.

The Vinamolds are supplied in three grades of different flexibility. Their properties and applications are shown in Table 1.

Properties, Grades and Uses

The compounds are true gels and liquefy on heating. Vinamold HMC.21 forms a liquid of medium viscosity at 150-155 degrees C. Vinamolds HMC.774 and HMC.776 melt and flow freely at 145-150 degrees C. The thermal conductivity, however, is low and care has to be taken when melting to prevent local overheating and decomposition. The compounds should not be heated to temperatures above 200 degrees C. (392 degrees F.). Vessels of glass, enamelled iron, stainless steel and aluminium are suitable for melting, but copper

*Chief Chemist, Vinyl Products, Ltd., Carshalton, Surrey.
†Registered trade name.

Table I.

Vinamold Grade	Colour	Softening point (Ring and Ball) °C.	Liquid at °C.	Viscosity of melt.	Elasticity	Use
HMC.21	light brown	131	150-155	medium	fairly rigid	plaster-cast resin
HMC.774	black transp.	139	145-150	low	flexible	cast resin
HMC.776	black transp.	136	145-150	low	highly flexible	plaster

should be avoided. Plain iron can also be used, but may have a detrimental influence if the compounds are kept in it for long periods at the melting temperature. Small quantities can easily be melted over a gas burner or an electric hot-plate with an asbestos mat, but constant stirring is necessary to prevent overheating. The stirring should be slow, taking care to avoid the formation of air bubbles which are difficult to remove.

The danger of overheating is considerably reduced by the use of an air, oil or graphite bath. A standard glue-pot is suitable if the outer vessel is left empty, or filled with a high-boiling mineral oil or graphite powder. The Vinamolds cannot be melted in a waterbath.

If a temperature-controlled oven of the gas or electric cooker type is available, the container with the compound (covered with a lid) is placed inside, and the temperature set to 160-180 degrees C. (320-356 degrees F.), only occasional stirring being required.

Larger batches are best melted in an oil or steam-heated jacketed pan; steam at 80 lb. per square inch minimum is required. Thermostatic melting pots are also available and these require little attention during the melting period.

Procedure in Forming Moulds

Models are made of non-porous materials, such as glass, china, metal or glazed stoneware, do not require preparation prior to pouring of the Vinamold, but porous articles made from plaster or earthenware, etc., should be pretreated to

Fig. 2.—The simple operation of making a flexible mould for a small object; the "Vinamold" is melted in an electrically heated, thermostatically controlled container.

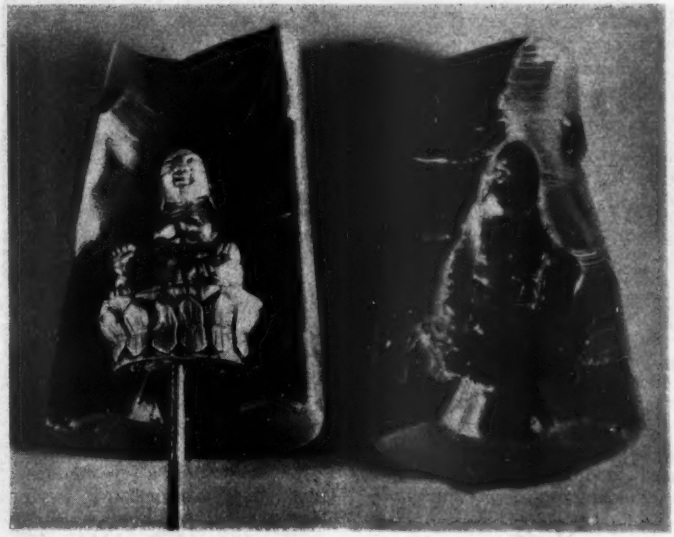


Fig. 3 (above).—The mould roughly cut open to show a brass image still resting in one half.

Fig. 4 (left).—Before being fully cut open.

seal the pores to prevent air blisters forming on the surface by expansion under heat. They should be given either a good coat of cellulose lacquer or immersed in melted paraffin wax until the included air has been driven out and the pores filled with wax. After draining and cooling the model it is ready for immersion in the compound. In cases where these methods cannot be employed, the use of vacuum technique is advised, i.e., the porous article is placed on a plate over a hole connected to a vacuum pump. A ring of plaster, paper or metal, is built around the model forming a container or case for the mould. While pouring the hot melt over the model the air is evacuated and thus prevented from escaping into the mould.

A feature of the Vinamolds is their ability to reproduce even the finest details of the surface of the model. Thus small blemishes on the model will show on the casting, and it is important to use great care in preparing the model before manufacture of the mould. It is always advisable to warm the model to prevent chilling of the hot melt, thus enhancing the faithfulness of the reproduction. Glass and china should in any case be carefully preheated to prevent cracking due to temperature shock. Reproductions in plaster and cast resin from polished

Fig. 5.—This image, and the nut and bolt, both of "Cataform" casting resin, were made by aid of "Vinamold" matrices.

or glazed models do not require any sanding, touching up, or polishing.

Moulds

The selection of the correct grade of Vinamold for use in a particular case depends largely on the size and shape of the object to be reproduced. Unsupported moulds are suitable for small articles. Case moulds, where the mould itself is supported in a permanent, rigid outer container, are necessary where the weight of the filling may cause distortion. For small objects it is frequently sufficient to have a thin layer of material about ¼ in. thick, and such a skin can be produced satisfactorily by dipping the model into the hot melt. It is advisable to leave the model to cool after dipping for a few minutes and then dip again. By repeating this process, a sufficient wall thickness can be built up.

For the larger objects the pouring method is more suitable. The model is either suspended upside down in, or placed on the bottom of a suitable container which may be of metal, plaster or even paper, and the hot melt poured into the cavity to rise slowly round the model.

One-piece moulds can be employed (even in cases where the removal through the filling hole would be difficult) by cut-

Fig. 6.—Group of moulds and castings: two of the moulds are peeled back to demonstrate the remarkable elastic nature of the particular "Vinamold" here employed.

Fig. 8.—The mould, copper original, plaster cast and "Cataform" cast, of Indian's head, showing precise reproduction of detail.

Fig. 7.—The elastic nature of "Vinamold" makes it easy to remove a cast from a one-piece mould.

ting open one side of the mould, thus allowing for the easy withdrawal of the cast object. The empty mould is held together by a case or an elastic rubber band, ready to be refilled.

Moulds which have to be made of several parts are made by filling with Vinamold up to the level of the intended parting line and leaving to cool. When the mould has cooled to room temperature it is filled up with more hot melt compound. The two grades of Vinamold, HMC.774 and HMC.776, will not stick to the cold compound, but in the case of HMC.21 the cold surface should be dusted with french chalk. After cooling the mould can be separated into two parts at the desired division line. Small rods should be moulded-in at the junction to ensure alignment. The model is removed from the cold mould and filling holes and air vents are cut where necessary. The mould is now ready for filling with the casting liquid.

No treatment of the mould prior to casting is required as neither plaster, cement, nor cast resin will adhere to the mould surface. Many hundreds of castings can be taken from one mould and, with careful handling, the last cast should be as perfect as the first. Using a gelatine mould, the maximum number of castings possible, however, is fewer than twenty. When the useful life of a mould is over, it can be melted down again. Vinamolds do not deteriorate through ageing or frequent remelting. Small blemishes, blisters or tears in the mould can be repaired by a heated knife blade over a very small gas flame (⅛-¼-in.).

Making the Casts

In casting either plaster-of-paris or cement the slurry is poured into the mould, and air bubbles are removed in the normal way by tapping or gently stirring with a rod. The cast is then left to set. It can be removed so soon as sufficient strength has been developed, but it may be left in the mould for any length of time as the mould will be unaffected

(Continued on page 164)

Cellulose Acetate Plastics

X.—Extrusion Methods of Sheet Production

By
Vivian Stannett

THE two main methods of sheet production have already been discussed. They both suffer from grave disadvantages. The block method is cumbersome, slow and discontinuous, and the size of sheeting possible is severely limited by the size of the presses, etc., which are available. The film-casting method is expensive, owing to the large proportions of volatile solvent used, and the thickness of sheet which it is possible to make by this technique is limited to a maximum of 10 to 20/1,000 in.

This latter difficulty has engaged the attention of film-casting technicians for many years, and a number of ingenious machines have been devised to overcome it. The main method attempted has been multi-layer casting, where one film is cast on top of another—partially dried—film, until the required thickness is built up. This is a laborious and over-sensitive process, and so far has met with little practical success; nevertheless, a number of machines based on this principle have been patented, and references to these will be given at the end of this series of articles.

More successful have been methods of sheet production based on extrusion. Until recently, attention was concentrated on the extrusion of sheeting from the plastic dough, containing a quantity of volatile solvent, the so-called wet extrusion process, and of these, the Fiberloid process has been markedly successful, especially for the production of 20 to 25/1,000-in. thicknesses for use as safety glass interlayers. Details of this process have never been made public, and a large number of patents[1] have been taken out by the company concerned, the more interesting of which are given at the end of this article.

Within the past two years or so a new technique of cellulose acetate sheet extrusion has been developed. This involves the extrusion of sheeting directly from "moulding" powder, and is consequently a solventless method. The complete absence of solvent from the system immediately gives it big advantages over other known methods. An obvious advantage is that, as no solvent evaporation is involved, the speed of production depends entirely on the speed of extrusion; already speeds far in excess of any other technique have been achieved. Again, no problem of seasoning is involved, and the sheeting is virtually ready for use as soon as it is produced. Furthermore, problems of shrinkage and warping due to the loss of residual solvent, such as are common with other types of sheeting, do not arise in this case.

One disadvantage is that the starting material is a cellulose acetate moulding composition, i.e., an already processed material, whereas other methods start with the basic raw materials themselves. However, this disadvantage is becoming minimized, as the methods of moulding production have now been speeded up considerably and their cost much reduced. In any case, the advantages of this new extrusion method far outweigh its drawbacks. So far as is known to the writer, the method has been worked as yet only on a semi-commercial scale, but these trials have been successful, and complete sheet extrusion machinery is now being produced by one company in the United States,[2] largely based on the experimental technique which has been developed by the Tennessee Eastman Corporation in the U.S.A.

Sheeting so far produced satisfactorily by this dry extrusion method has been limited to a width of 24 ins. and with a thickness range of from 10/1,000 to

TENITE GRANULES
FEED HOPPER
CIRCULATING WATER APPROX. 70°F.
CIRCULATING HOT OIL
2½ DIA SCREW HOT HEATED 41 R.P.M. APPROX
35 MESH WIRE SCREEN AND SUPPORTING PLATE
APPROXIMATE OVERALL LENGTH 25 FEET
WATER COOLED SPREADER DEVICE APPROX. 70°F.
ELECTRIC HEATER-2500 WATT JACKET TYPE
ELEVATION AT 'A' OF SPREADER DEVICE
5" DIA PULL OUT ROLLS
OUTSIDE AIR RING-AIR TEMP 200°F
SPLITTER BLOCK
AIR RINGS-AIR TEMP 200°F.
PIPE RING 3" DIA
5" DIA PULL OUT ROLLS STEAM HEATED TO 220°F
4" DIA TENSION ROLLS ROOM TEMPERATURE
CENTER LINE OF MACHINE
PERFORATED COOLING PIPE-AIR AT APPROX 80°F
12" RUBBER CONVEYOR BELT USE OPTIONAL
TO CUTTER OR WIND UP
DIMENSIONS GIVEN ARE APPROXIMATE

Fig. 1.—Diagram of equipment for extruding "Tenite" sheeting. (Courtesy, Tennessee Eastman Corporation, U.S.A.)

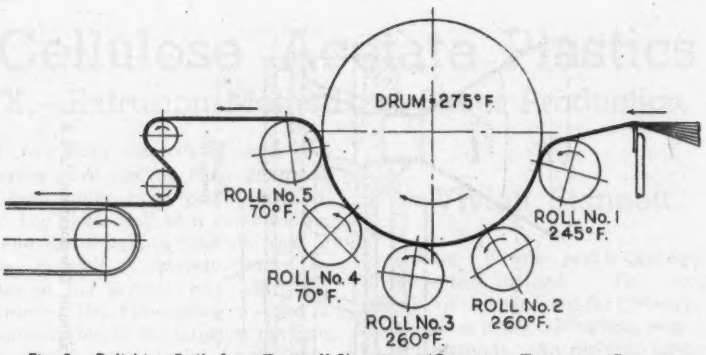


Fig. 2.—Polishing Rolls for "Tenite" Sheeting[5]. (Courtesy, Tennessee Eastman Corporation, U.S.A.)

50/1,000 in. There seems no reason, however, why the maximum width possible should not be increased, although increase in thickness above 50/1,000 in. may present great difficulties, particularly if transparent sheeting is required.

The broad principles of the method involve the extrusion from moulding powder of a tube, which is slit immediately it emerges from the die. The remainder of the plant is largely taken up in gradually spreading and flattening the split tube to a perfectly even and flat sheet. When a high polish or transparency is required, this is carried out by a specially developed series of rolling operations.

The Extruder and Die

The extrusion machine used (Fig. 1) is of a standard screw-feed design, fitted with a variable-speed drive. The cylinder is divided into three independent heating regions. Near the feed end, water cooling is carried out to prevent sticking, the temperature being maintained at 80 to 90 degrees F. The centre section is heated by hot oil circulation to a temperature of 300 to 350 degrees F., whilst near the die a second hot oil jacket raises the temperature to 350 to 400 degrees F. The speed of the screw is quoted as being in the region of 40 to 75 revolutions per minute for normal working. The operating temperature depends, of course, on the flow temperature of the moulding composition and also on the rate of extrusion required.

The screw of the extruder is not fitted with a heating element, but is heated by conduction and friction. The cylinder and screw of the extrusion machine are made of high-grade steel, and it is recommended that those parts which are in contact with the molten plastic are chromium plated. Before entering the die the plastic is forced through a wire screen of about 28 mesh, supported by a baffle plate, drilled with $\frac{1}{8}$-in. diameter holes. This helps to homogenize the material and to give a greater uniformity of temperature, in addition to removing any foreign matter which may have entered with the powder.

The die consists of a cylindrical shell with a torpedo insert. Both parts of the unit are electrically heated to a temperature of about 350 to 400 degrees F. Two rings of stainless steel are inserted at the outlet end of the die; these form the tube into its final thickness. To give a tube of uniform thickness, set screws are provided to adjust the relative position of the outside ring to the inside. All parts of the die and rings are finely finished and highly polished, in order to minimize any irregularities or marks on the extruded sheeting. At the bottom and up against the orifice from which the extruded tube emerges, a small brass wedge is fixed; this cuts the tube as it issues from the die. To minimize dragging, the wedge is hollow ground at the ends.

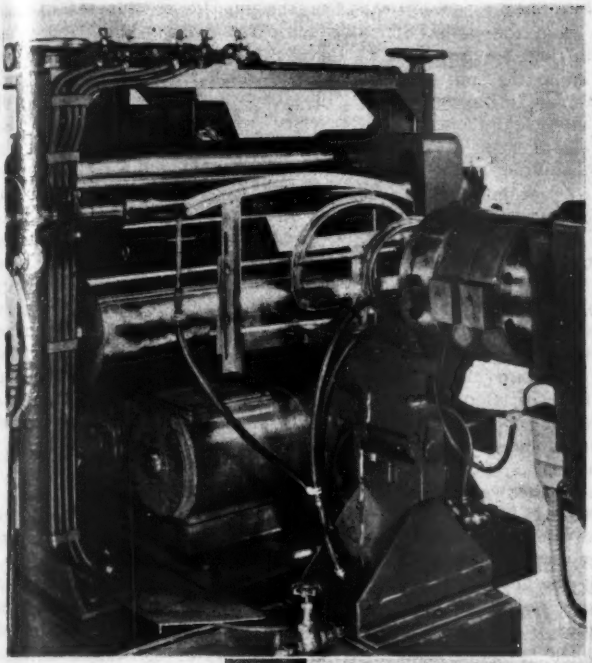


Fig. 3.—NRM Direct-process Sheeting Machine: looking over the spreader bars into the take-off unit. (Courtesy, National Rubber Machinery Co., Akron, Ohio, U.S.A.)

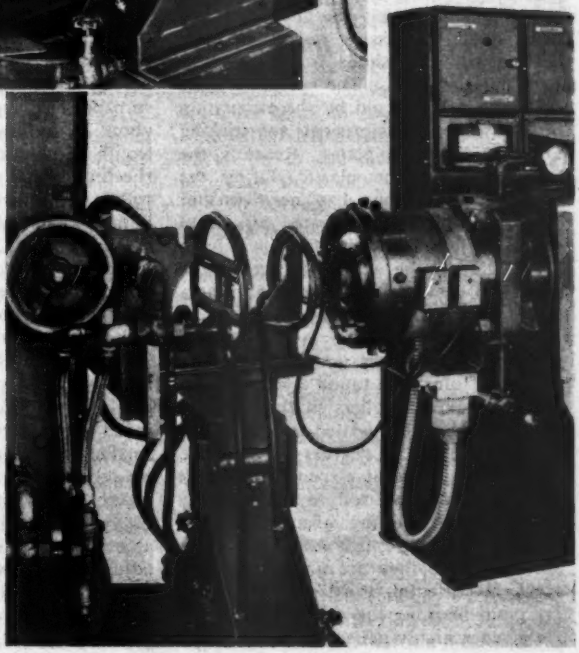


Fig. 4.—NRM Direct-process Sheeting Machine: close-up view of 9-in. circular sheeting die, together with spreader bars. (Courtesy, National Rubber Machinery Co., Akron, Ohio, U.S.A.)

Forming into Sheet

A short distance from the outlet of the die, special tubular rings are arranged to blow heated air on to the split tube as it emerges. These are arranged so that the air is blown on to both the inside and the outside of the tube. The temperature of the air is adjusted to set the sheet to a self-supporting condition, but at the same time to leave it with sufficient plasticity to undergo the flattening operations which are to follow. Other functions of the hot-air blast are to prevent the condensation of vaporized plasticizer and also to prevent any cooling of the die which would slow down the extrusion process. It would seem that the correct adjustment of the air temperature is the important factor in preventing any distortion or wrinkling of the sheeting by the subsequent operations.

The split tube is then gradually flattened out by passing it over two brass spreading-plates and a spreading-bar, all of which are carefully bevelled to prevent dragging. The three units are of gradually increasing radius in order to transform the shape from a tubular to a flat condition. The spreading-plate surfaces are kept cold by the circulation of cold water. This prevents any sticking of the plastic to the plates. Recently, the temperature of the plastic during the spreading operations has been further controlled by blowing heated air on to it before it touches the first two bars. This "chills" the actual surface of the sheet and prevents scratching and marking of the plastic by the bars.

Immediately after the last spreading-bar, the sheet passes under a flattening roll, and from there round a set of 12-in. diameter take-off rollers in the form of an "S." These are heated to a temperature of about 250 degrees F. and are fitted with a variable-speed drive. It is stated that these rolls operate simply to draw the sheeting away from the extruder and through the flattening operation, and they are not intended to exert any flattening or calendering effects. To avoid marking the sheeting, the rolls are given a highly polished finish.

The sheeting leaves this set of rolls and then passes over an idling roll, when it travels about 4 ft. across to another idling roll which feeds it into a further set of take-away rolls in the shape of a reverse "S." Slight tension is applied to the sheeting by the second set of rolls, which are also fitted with a variable-speed drive and are kept at a temperature of 80 to 85 degrees F. by cold-water circulation. The application of tension holds the sheeting firm and flat while it is cooling. The 4 ft. of film which are exposed between the two sets of rolls provide a convenient place for inspecting the quality of the sheeting, checking the thickness, etc. The cool and flat sheeting is then carried through edge trimmers and the trimmed sheeting either wound on reels or cut into desired lengths.

Polishing the Sheet

Sheeting produced by this method does not have a perfect polish such as is often necessary for transparent qualities. Polishing is carried out by passing the sheeting through a specially designed set of polishing rollers. These are situated in the production line after the last spreader bar, and consist of a large drum about 24 ins. in diameter and of sufficient length to handle the maximum width of sheeting being produced. Five smaller rollers are evenly spaced around the bottom half of its circumference, as shown in Fig. 2. The large drum and the five small rolls are all finished with a highly polished chromium-plated surface, and are hollow so that they can be heated by circulating hot oil, water or 90-lb. steam. Steam or water is said to provide the superior heating medium.

The large drum is driven by a variable-speed direct-current electric motor, the smaller rolls are not driven but are rotated by contact with the sheet as it travels round with the large drum. Each of the small rolls is fitted with bearings at each end which are capable of being adjusted towards or away from the drum, i.e., the distance of the clearance between each individual small roll and the drum can be adjusted and set to any desired

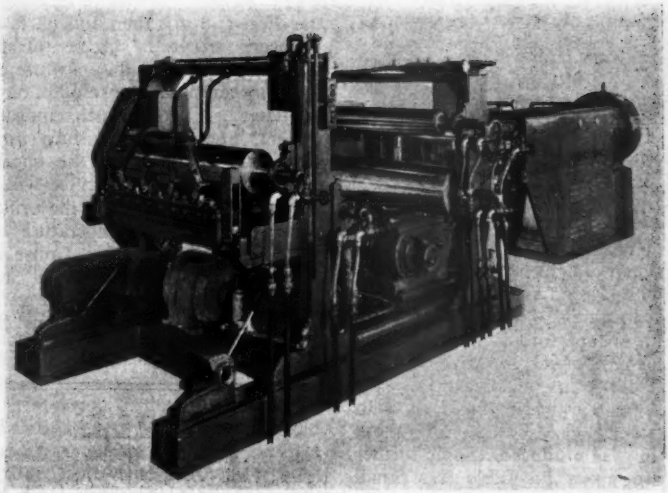


Fig. 5.—NRM Direct-process Sheeting Machine : view of entire unit, showing cut-off mechanism for cutting sheeting if required as alternative to the take-up roll. (Courtesy, National Rubber Machinery Co., Akron, Ohio, U.S.A.)

value. The bearings of the small rolls are spring loaded, so that variations in the thickness of the plastic sheet may be taken up without ill effect. Very stiff springs, which require about 600 lb. for ½ in. of deflection, are used.

The large drum is kept at a higher temperature than the smaller one; this temperature is of the order of 275 degrees F. This means that the sheet adheres firmly and smoothly to the large drum as it travels round, while the smaller rolls exert an ironing effect, both sides of the sheet receiving a polish from the polished surfaces of the roll and the drum.

The first small roller under which the sheeting passes is kept at a temperature of 245 degrees F., with a surface clearance of about 0.006 in. for 20/1000 in. thick sheeting. This particular roll carries out the task of setting the sheeting flat against the large drum and ironing out any air or gas pockets. The second and third rollers carry out the bulk of the effective polishing of the sheet. They are both set at the same clearance as the first roll and kept at a temperature of 260 degrees F. All these three rolls are at practically full tension. The fourth and fifth rolls are cooled to about 70 degrees F. by circulating cold water through them, and are lightly loaded. These cold rolls act to cool the sheet to a rigid condition for removal from the drum. Cold air is also blown on to the sheet at this stage to accelerate the cooling.

After leaving the drum, the polished sheeting is passed through the nip of two rubber rollers which maintain sufficient tension on the sheet to carry out its smooth withdrawal from the drum. The sheeting is finally trimmed and reeled or cut into sheets as before. The two main considerations for successfully operating the polishing process are stated to be exact temperature control and the utmost attention to cleanliness. The chromium plate is kept clean by wiping with soft cloths, using a suitable polish when necessary.

Adjusting the Thickness

The thickness of the sheeting to be produced is adjusted mainly by changing the rings of the extrusion die. Tennessee experience showed that the length of the

Table 1.—Orifice sizes for varying thicknesses of sheet.[3]

Thickness of sheet (in.)	Orifice opening (in.)	Length of land (in.)
0.020	0.022	3/8
0.025	0.028	3/8
0.030	0.035	3/8
0.035	0.040	3/8
0.040	0.045	3/4

land (lip) had also to be changed to give good results. As an example of a drastic change in thickness, the following figures are given: An aperture of 0.030 in. with a land length of 1⅛ in. gave sheeting about 25/1000 in. in thickness. On changing the aperture to 0.007 in. with a land of ⅜ in., sheeting of about 10/1000 in. was produced. Some further figures are given in Table 1. Small differences in thickness can also be made by changing the tension on the sheeting, but if too great a change is effected in this way, excessive strains are set up in the sheet and it is then difficult to flatten.

Special extrusion grades of powder should be used and the moisture content carefully adjusted before addition to the extruder. If too much moisture is present, bubbles and surface imperfections are produced in the sheet, and uneven flow from the orifice will result. Surging of the flow from the orifice will also occur if the temperature of the powder is not uniform. Consequently, the compound must be dried in such a way as to avoid temperature variation, such as storing whole drums of the material in hot rooms, before use.

REFERENCES

(1) *U.S.P.* 1,837,854 (1931); *U.S.P.* 1,837,855 (1931); *U.S.P.* 2,002,711 (1935); *U.S.P.* 1,993,349 (1935); *U.S.P.* 2,061,042 (1936); *U.S.P.* 2,090,404 (1937). **(2)** *National Rubber Machinery Co., Akron, Ohio.* **(3)** *Modern Plastics*, 1946/23/132. **(4)** *Modern Plastics*, 1948/25/104. **(5)** *Tennessee Eastman Co., technical literature.*

Sebacic Acid and Plasticizers

ANNOUNCEMENT of the formation of The Geigy-Hardesty Co., Ltd., is of interest to the plastics industry, as this new company is to engage in the production of sebacic acid and related compounds.

According to a statement issued by the board of The Geigy Co., Ltd., at Manchester, this development is regarded as a timely extension of their own activities as plasticizer manufacturers, involving the bulk production in England of high-grade sebacic acid. The sebacic acid and related plasticizers are noteworthy for their efficient plasticizing action and the relative insensitivity to temperature of vinyl and rubber compounds made therefrom. In addition, sebacic acid will be made available for use in the manufacture of polymers such as nylon, alkyd resins, and in other fields of chemical industry.

It is anticipated that the new development will ultimately make Britain independent of imports of sebacic acid, for which the U.S.A. have so far been the world's principal producers. A domestic source of sebacic acid for polymer makers, and the use of its compounds as plasticizers, should also play a large role in increasing the range of home manufactures, of which part will ultimately go to expand British exports.

In order to effect the most rapid and economical production of sebacic acid and related compounds, the new company has been formed with the co-operation of The Hardesty Chemical Co., Inc., of New York, who are the leading manufacturers of these products in North America. The processes and experiences of this American company will be fully utilized and adapted in the English plant, which is to be located adjacent to the Trafford Park unit of Geigy, where plasticizer chemicals are already made.

Manufacturing arrangements have been scheduled to take effect over a period of time, but a substantial tonnage production should commence later this year. The flow of material will be integrated with Geigy's plasticizer production, and supplies will additionally be available for others, for instance, in polymer making. Likewise the flow of material will run parallel with the increasing plasticizer needs of this country, which are contingent on the growing use and production of the polyvinyl resins.

Cup and Saucer of Novel Design

IN the November, 1947, issue of "Plastics" (page 571) we published an article, of continental origin, on plastic tableware, for which the author claimed certain advantages of saving in weight by comparison with ware made of porcelain, and likewise a saving in storage space by virtue of the fact that cups, saucers and the like were so shaped that they stacked in a manner far more convenient than was possible when shape was a conventional one.

On the occasion of the Hotel, Restaurant and Catering Exhibition, recently held in London, we found a British product embodying somewhat similar features, i.e., the cup and saucer which is the subject of the accompanying illustrations.

This cup and saucer, of "Perspex" (⅛ in. thick at the lip) in a range of pastel shades as well as white, is a production of Parco Industries, of Slinfold, Horsham, Sussex. It is made by the commonly adopted method of pressing the thermoplastic upon a former, but the actual shape, which is a registered design, has been given a due amount of careful thought in order to attain its object.

Apart from the matter of lightness, there has been achieved a notable ability to stack, which, in the case of the cups,

suffers little hindrance from the position of the handle. Moreover, as seen from one of our illustrations, the cup and saucer may be tipped to an angle of 40 degrees from the normally horizontal position without risk of the cup sliding from the saucer; indeed, we have safely carried the two articles tilted to an angle of 35 degrees whilst walking

unhesitatingly about the room. This exceptional degree of stability is achieved by the shape and extent of the depression where the saucer receives the base of the cup. This "non-spill" cup and saucer is being put into production mainly to serve requirements of air, rail and sea transport.

World's Industry Employs Plastics

GENERAL ENGINEERING

Deep Drawing of Metal.—When deep-drawing sink bowls of stainless-steel sheets, plastic coated, scratching can be completely avoided, eliminating the need for hand-finishing or polishing. Strippable plastic coatings have proved of benefit also in other forming operations. ("Products Finishing," 1948/Jan./54.)

Drilling Technique.—Factors to be studied in the drilling of plastics are enumerated in a shop data sheet. During certain tests the colour of the drill was observed. Capacity was increased by 200 to 300 per cent. when an airblast was used. An included angle of 60 degrees proved to be definitely superior. Friction can be reduced by grinding drill off-centre. ("Tool and Die Journal," 1948/Jan./65.)

Laminates.—High strength, low-pressure-moulded reinforced plastic laminates, which in many aircraft tools have been accepted as standard tool material instead of steel, are reviewed by L. Wittmann. ("Tool and Die Journal," 1948/Jan./68.) The material characteristics, design considerations and adaptability to tooling in other industries are discussed in this illustrated article.

Contact wheels for abrasive belt polishing are made of Neoprene, in a wide range of densities to adapt them to a variety of work; these wheels are product of Manderscheid Co., 810, Fulton Street, Chicago 7, Ill. ("Machine and Blue Book," 1947/Dec./155.)

Synthetic coating used primarily for insulating and protecting electro-plating racks is also offered as protection for equipment to withstand chipping and tearing. The Unichrome coating of United Chromium Inc., 51, E.42 Street, New York 17, is applied by dipping or spraying and cured at 350 degrees F. ("Automotive Industries," 1947/Dec. 15/52.)

Brake linings.—The bonding of brake linings to shoes is finding more and more interest with American car manufacturers. ("Automotive Industries," 1948/Jan. 15/84.)

Testing.—Workers at the Massachusetts Institute of Technology have developed a universal testing machine for investigating the properties of plastic materials and their sensitivity to time rates and ambient atmospheric conditions. ("A.S.T.M. Bulletin," 1947/Dec./51.)

Fatigue-testing.—Creep, long-time tensile, and flexural fatigue for melamine and phenolic plastics are reported by D. Telfair, C. H. Adams and H. W. Mohrman. ("Am. Soc. Mech. Eng. Trans.," 1947/Oct./789.)

MISCELLANEOUS

Welder's Helmet.—Covers of a special grade of Perspex have recently been introduced by Murex Welding Processes, Ltd., for the coloured filter glasses in the helmets or hand screens used by welders; spattering and scratching of these sensitive parts are thus prevented. ("Machinery" (London), 1948/Jan. 22/121.)

Production of plastic moulds from metal-master patterns, and of plastic castings by use of home-made moulds, is described in illustrated article ("Science Illustrated," 1948/Jan./92). The moulds are made from Arco-Flex, which solidi-

fies to a rubberlike solid; castings are of Plastone, a liquid resin mixed with plaster of Paris. Arco-Flex is produced by Applied Resins Corporation, 304, Oraton Street, Newark, N.Y.; Plastone, by Efam Plastic Co., Moorestown, N.Y.

Plastic-bonded rod for wire-metallizing equipment is composed of powdered Colmonoy (Wall Colmonoy Corporation, Detroit, Mich.) combined with plastic binder and extruded to $\frac{1}{4}$ and $\frac{1}{16}$-in. ("Machinery" (N.Y.), 1947/Dec./184.)

Welding hard P.V.C.—The welding of hard polyvinyl chloride, brand Vinidur, is reported upon by P. Voigt. He reviews the satisfactory welding conditions by using hot air; the high-frequency welding is not discussed. ("Kunststoffe," 1947/Sept./190.)

Upholstery material composed of synthetic yarns is being used by Chrysler in some of its 1948 station wagons and convertible models. The seat material is washable, spot-proof, stain-proof, and acid-proof, and is said to give double the service of wool or cotton. ("Automotive Industries," 1948/Jan. 15/18.)

Helicopters.—The blowing of transparent enclosures for helicopters of the Bell Aircraft Corporation is described in detail by K. Rose; one of the requirements is that the "acrylate" cover be optically flawless. ("Automotive Industries," 1948/Jan. 15/40.)

Food packages.—Cheese wedges are packed in transparent plastic boxes by Kraft Foods Co.; the polystyrene container not only permits the cheese to be seen, but can later be used as trinket box. ("Food Industries," 1947/Nov./114.)

Recovering scrap.—Celanese Corporation of America has developed a new method for recovering scrap. A sample batch of scrap plastic is analysed and a formula for its reuse is developed; 10 per cent. of virgin material is used with each batch. ("Business Week," 1947/Oct./18.)

Optical parts.—C. T. Kautter deals with the production technique for organic and laminated transparent materials on acrylic bases. He refers to many manufacturing problems which occurred during the war when these materials were used in aircraft production, and which may now be useful in manufacturing optical parts ("Kunststoffe," 1947/July/141.)

Transparent sighting fixtures for complex castings are suggested by Moore Special Tool Co. The part can be accurately located by bushing and sighting plugs before machining. In one special case about 8 hours in layout time could be saved by 15 minutes of visual inspection. ("Machine Design," 1947/Dec./112.)

Acid brush, produced by The Eraser Co., Inc., 104, S. State Street, Syracuse 2, N.Y., has a soft tuft of fibreglass solidly embedded in a wood handle. When wet the fibreglass becomes soft and pliable. It can be used in any acid which does not affect glass. ("Prod. Finishing," 1947/Jan./120.)

High-frequency preheating in relation to plastics is reported upon by E. A. Veillon, who states that, correctly applied, important improvements in quality can be obtained. The moulding of a plastic cup is described in detail. ("Schweiz. Archiv angew. Wissenschaft and Technik," 1948/Jan./19.)

SOURCES OF REFERENCE

We wish to remind readers that the sources of reference from which these pages are compiled are not, in general, retained in this office. We cannot, therefore, undertake to supply such originals. Nevertheless, most of the foreign journals referred to are available in the Patent Office Library (Southampton Buildings, Chancery Lane, W.C.2) and in the Science Library (South Kensington). Photoduplicated copies of articles may be obtained from the Photostat Dept. of the Patent Office.

New Uses for Nylon Monofilament in Brush-making

THE bulk of the nylon monofilament made in Great Britain is absorbed by the brush-making trade, which produces a wide range of nylon-tufted brushes for toilet, domestic and industrial purposes. Although nylon brushes are well known and their value for established applications fully assessed, it is surprising how varied are the applications now found for them in industry; moreover, the availability of nylon-tufted brushes has extended the range of brushes in processes where hitherto they have been ruled out owing to the limitations of natural bristles.

In the toilet field, considerable success has been achieved by using nylon tufts in combination with methacrylate backs, the latter lending itself to effective streamlining. A good deal of ingenuity is being shown in the designing of new toilet brushes and well-known designers are collaborating with makers to produce brushes that combine attractive appearance with unusual practical qualities. One new hand-brush consists of a square of nylon tufts in the rectangular brush back which is for scrubbing the hands, whilst at an angle perpendicular to this and parallel with the longer axis of the moulded block of acrylic resin runs a single row of tufts for nail-cleaning purposes. Just below the row of tufts is a projection of the brush back, which acts as a shelf on which to steady the fingers.

It is not only for nailbrushes, hairbrushes and toothbrushes that nylon finds applications in the toilet brush field: the range includes delicate eyelash brushes, bath brushes, clothes brushes and shaving brushes. In this country only a very limited use has yet been found for nylon monfilament in shaving-brush manufacture, which calls for a special tapered filament. Experiments are, however, being undertaken, and it is likely that this particular application will be developed.

A good deal of quite advanced development work has been carried out on the use of nylon monofilament for domestic brushes, these including sweeping brooms and various kinds of hand-brushes for the home. In some cases the brushes are made up from nylon and natural bristle and in other cases 100 per cent. nylon is employed.

Turning from toilet and domestic to

Fig. 1.—Nylon brushes, with "Alkathene" stocks, as used in a modern industrial washing machine. (Courtesy, Plastics Division, I.C.I., Ltd.)

Fig. 2.—Group of nylon-tufted brushes as used in Dixon scrubbing and shampooing machine. Brushes made by Nash Brush Works, Watford. (Courtesy, Plastics Division, I.C.I., Ltd.)

industrial brushes, a wide field of application is offered. Whilst in most cases the stocks for nylon tufts are wood, some use is being found for polythene, which offers in particular the following advantages: (1) Excellent resistant to chemical attack and solvent action; (2) extremely low moisture absorption; (3) dimensioned stability of the stock under ordinary usage conditions; (4) ease of machining and general brush-making operations.

The most likely uses for polythene brush stocks are in those trades where wooden stocks cause trouble owing to the presence of chemicals, dyes and where cleanliness and hygiene are sought after by users. Dirt which collects during use of the brush is plainly visible on the white polythene stock and can be removed very easily.

Experience is showing that nylon-tufted brushes are of special value in the food-processing trades. One outstanding advantage is the fact that, owing to the high strength and resiliency of nylon monofilament, there is a greatly reduced liability of the brush shedding bristles. Broken bristles often find their way into foodstuffs and have been known to be the source of serious complaints, and even legal actions. Where brushes are used in food-processing machinery, such as fruit-pulping and flour-sifting units, it is most important that no shedding of bristles should occur. Nylon-tufted brushes are the most hygienic in general use. They can be washed and kept perfectly clean; moreover, sterilization may be carried out in boiling water or steam.

The uses of nylon-tufted brushes in the textile-printing trade are now fairly well known, but not quite so familiar are the applications found for them in the paper trade, engineering and shoe trades, all of which call for high-strength and resilient brushes.

A good deal of development work is being carried out in this country on tapered nylon for making paint and distemper brushes. Natural bristles have a characteristic structure which enables them to retain liquids, such as paints, and to spread them evenly over wall surfaces, and work is proceeding on nylon so as to achieve similar effects.

PLASTICS IN GERMANY

The New Target in Germany is the Science behind the Industries. The following are additional Notes from the Official Reports which can be obtained from H.M. Stationery Office.

F.I.A.T. Final Report 1102.—Production of polyvinyl acetate resins in Germany was centred at two plants—those of the I.G. at Hoechst and the Alexander Wacker Co. at Burghausen. Both companies manufactured their own monomer, and practically the entire production was used internally. The present report provides additional data on the manufacture of polyvinyl acetate resins as here practised. Procedures at both plants were somewhat similar in that dispersion, pearl, solution, and bulk polymerization processes were used. Processing details for the several products were comparable, the outstanding differences being in formulation and in the use of continuous bulk and solution polymerization by the I.G. At maximum capacity this Hoechst plant produced 700-800 tons of monomer per month; Burghausen produced 200-250 tons per month. A major portion of the pearl polymer production at Hoechst (5 per cent.) and at Burghausen (15 per cent.) was converted to polyvinyl alcohol; 8 per cent. of the Hoechst production was sold to the I.G. plant at Ludwigshafen for conversion into copolymers with acrylic esters.

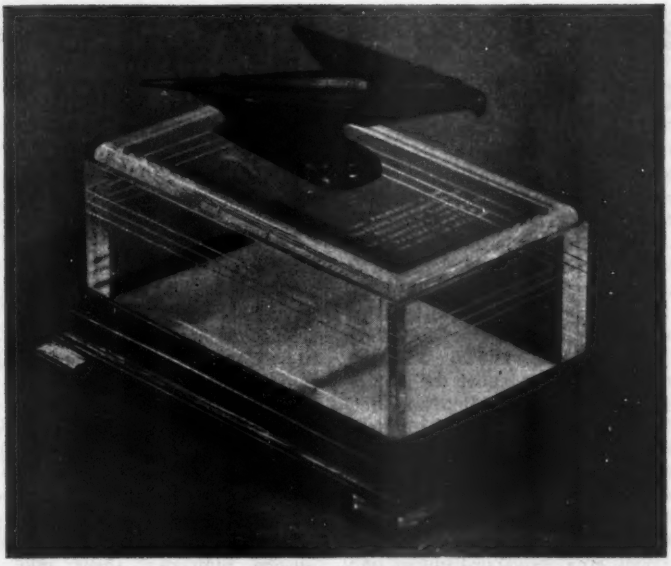
Vinyl acetate dispersions at Hoechst (Mowilith D) were made with a high viscosity, acid hydrolyzed, butyraldehyde modified, polyvinyl alcohol having a saponification number of 3 to 4. Formic acid was used in the formulation supposedly as an agent to reduce the inhibition period of the polymerization reaction. At Burghausen, on the other hand, a high viscosity alkali-hydrolyzed polyvinyl alcohol with a saponification number of 100 was employed, the claim being made that a relatively high acetate content in the dispersing agent was essential to obtain stable emulsions. Hoechst claimed that their dispersion could resist freezing, whereas Burghausen indicated that this resistance varied from batch to batch. Some improvement in freeze resistance was noted when methyl alcohol or ethylene glycol is added.

Three grades of solution-polymerized vinyl acetate were made at Hoechst by a two-tower continuous process; here Ethyl acetate was used as solvent, and K values were varied by adjusting catalyst and aldehyde concentration. A vinyl acetate-crotonic acid polymer was made batchwise by solution polymerization.

B.I.O.S. Final Report 1105.—This report covers certain aspects of the manufacture and polymerization of butadiene, styrene, vinyl chloride and 1.1-dichlorethylene, as revealed at the interrogation of Dr. Carl Wulff, who was director of the I.G. Buna-werke at Schkopau. Regarding vinyl chloride, it was normal to obtain 85-90 per cent. polymerization. Sodium carbonate was always added to the latex before spray-drying it; this gave a stabilizing effect. The spray-dried particles were primarily hollow spheres with a blowhole on one side; the walls of the sphere then crumpled in. Dr. Wulff could not explain the cause of instability in p.v.c., nor throw any light on the appearance of hydrochloric acid and coloration being interdependent. The spray-dried polymer was universally employed, being generally more useful, and, indeed, the only polymer applicable to the manufacture of pastes; coagulated polymer was not employed for pastes, due to the resulting low stability. For the fabrication of unplasticized p.v.c., the polymer was stabilized with α-phenyl indole, mixed into the dry powder. Unplasticized p.v.c. was formed to some extent by impact moulding; the polymer was preformed, the preform heated and stamped to the final shape in an impact press. This process, used for small articles, had produced valve and screw parts.

B.I.O.S. Final Report 1,291.—This report concerns the German acetylene chemical industry and the manufacture of vinyl acetate monomer. Several flow sheets are reproduced, together with much data upon dimensions of plant and method of operation.

B.I.O.S. Final Report 1,412.—Descriptions of the Burghausen/Salzach and Hoechst/Main vapour phase processes for the production of vinyl acetate are here given, the process being characterized by high yields and low by-product formation. The crude vinyl acetate is a mixture of approximately equal parts of vinyl acetate and acetic acid, containing less than 2 per cent. acetaldehyde, ethylidene diacetate, and other liquid by-products. High-purity acetylene gas and acetic acid are essential, and the consumption of catalyst then amounts to 0.5 to 0.7 lb. per 100 lb. of refined vinyl acetate produced.



Clear polymethyl methacrylate, suitably engraved, with base and symbolic adornment in carved wood, is used for this presentation casket made for Vauxhall Motors, Ltd., by the Plastics Division of Leon Goodman Displays.

A similar casket, also by Leon Goodman Displays, uses the clear engraved acrylic resin in combination with opal material for the base.

Hard Nickel Electro-formed Moulds Position Reviewed After Four Years

By P. SPIRO
B.Sc. (Eng.), A.C.G.I., A.M.I.Mech.E.*

IN "Plastics" for May, 1944, there was reprinted an article entitled "A New Process for Making Moulds by Electro-deposition," which was originally published by the Institution of Production Engineers, in November, 1943. The introductory remarks to this article illustrated the time- and money-saving claims of the new process in the following words: "It is well known that the ordinary toolroom is one of the bottle-necks in the plastic moulding and die-casting industries. Moreover, the cost of moulds and dies, specially in the case of intricate shapes, is very often a decisive factor in the manufacture of the finished product."

In summing up four years of further development work, as carried out by one particular firm, it can fairly be said that the process in question has indeed been "a decisive factor" in deciding on and carrying out the manufacture of a large number of products.

It will be recalled that the electro-forming process is based on the accurate machining or carving of a plastics master, giving this a high degree of finish. On this master a shell of hard nickel (500 V.P.) is electro-formed, and from this the master is removed, after which the shell is given a mirror finish. It is then mounted in a steel bolster.

The main advantages of this process lie in the relative ease with which a positive master, as opposed to a negative cavity, can be cut, particularly in an easily machinable plastics, using much lighter machine tools than on steel and building up complicated masters by cementing them from simpler sub-sections, and yet obtaining a hard cavity in one piece (no gradual flash-penetration between parts of the cavity) without heat-treatment-scaling or distortion and without machining marks. Dimensional checking is also easier on a positive master and, moreover, an error on the master can always be remedied while a cavity machined "over" is very often unusable.

Since the first appearance of the article already mentioned, the general problem of backing has become simplified by the increasing thickness and strength of the nickel shells, and the addition of a hard copper layer behind the nickel shell filling in those parts where the nickel is not at its maximum thickness. This has been assisted by the development and perfection of a technique of machining the finished bimetallic shells into simple geometrical shapes (e.g., cylinders and cubes), the surface of which is partly nickel and partly copper. These are fitted into steel bolsters machined to the same simple, but definite shapes. It will be readily understood that the result is mechanically very much like a mould made wholly of steel, particularly because there is contact between the hard nickel and the steel bolster at the points of highest pressure.

Electro-formed moulds have met with two main prejudices:—

(1) That they will not give a faithful reproduction with sharp corners, etc.

(2) That they will "collapse" or "sink."

The first point has been handed down from the time when electro-forming meant wax masters made conductive with a graphite or bronze layer. It will be appreciated that a precision milled master in a resin selected for its dimensional stability and made conductive with a chemical silver mirror, which has been estimated as being of a thickness of

* London and Scandinavian Metallurgical Co., Ltd.

approximately one millionth of an inch, is a different proposition.

The second prejudice is of similar nature. The background here lies in the fact that not so long ago electro-forming meant copper electro-forming and backing usually meant white or soft metal backing. The fears resulting from this are deep-rooted, and now militate against the hard nickel tools.

The writer recalls one case where he was asked to investigate a "collapsed" tool. This was a multi-impression injection moulding tool where, perhaps unwisely, the hard nickel cavities had been mounted in a bolster which was only of mild steel and which had been unable to hold the pressure passed on to it by the high power injection moulding machine through the hardened sprue bush. The picture was indeed impressive. The half-dozen or so islands of hard nickel stood firm in a sea, as it were, of mild steel which had flown in all directions. The result was taken to be another confirmation of the collapsing tendency of electro-formed moulds!

This is not to say that there have been no cases of sinking with hard nickel moulds. However, the main point is that the two principal misgivings usually put forward against electro-formed moulds are of negligible importance in practice. Those versed in the art will in any case know that even steel cavities (e.g., hobbed), when let separately into a bolster, will sink a little at first until they are "bedded in," and, as said before, the finished mould is essentially a steel mould with a hard nickel skin and its mechanical properties will, therefore, be that of the steel used. However, the use of alloy steel is usually unnecessary. Incidentally, the nickel is not stained by urea. A flash of chrome on the nickel does sometimes help ejection, and there is no difficulty in applying this.

At the time of writing the only possible remaining trouble of electro-formed cavities is possible brittleness of the nickel, and this too has been greatly improved and will be overcome to an ever-increasing extent. It is in the interest of all concerned to know about this and to see it in its proper perspective. It is some achievement to have mastered the art of electro-forming a nickel-alloy shell of 500 V.P. hardness (48 Rockwell C), i.e., a surface sufficiently hard for most plastics purposes and immune to normal abrasion and denting.

Such hardness cannot be achieved without some loss of ductility. Extensive tests have shown that the nickel is no more brittle than hardened and tempered tool steel of the same dimensions and hardness. Yet the fact remains that a hard shell, however carefully backed, will be subject to certain mechanical dangers, knocks, etc. This is one of the reasons why the process has been most successful on small cavities where the ratio of the

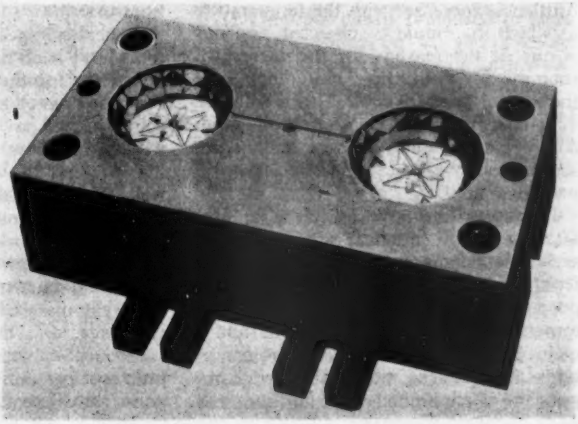


Fig. 1. — Electro-formed hard nickel mould for butter dish. (Courtesy, Lustroid Ltd., Coatbridge.)

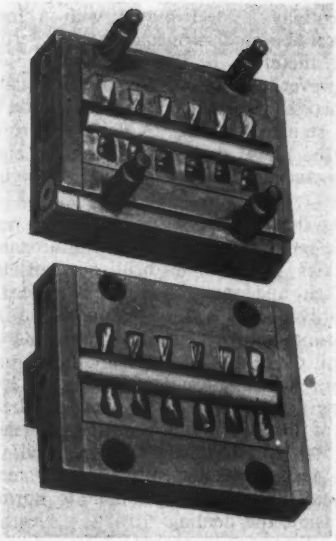


Fig. 2.—Electro-formed multi-impression mould for making acrylic resin artificial teeth.

wall thickness of the shell to the total size is higher than in large jobs.

It so happens that the economic incentives are also largest on small cavities, as such cavities are usually the most difficult and expensive to manufacture by other methods. It further happens that the brittleness increases with the temperature to which the mould is subjected, and this is one of the reasons for the success of such moulds in injection moulding where the moulds are kept cool. This is a source of danger, though a very small one, with compression moulding where moulds are sometimes overheated, particularly on primitive plant.

It is surprising how difficult it is, even after years of practical application, to arrive at conclusive figures about runs from the tools we are describing. For this purpose repeat orders from "satisfied customers" form a qualitative, but not a quantitative test. Under war-time conditions the frequent modification of components often limited the runs required

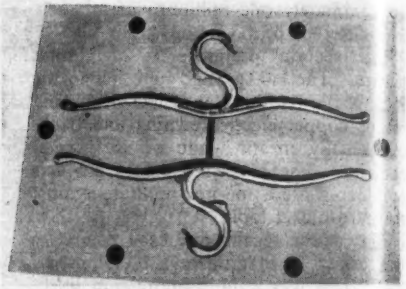


Fig. 3.—Electro-formed injection mould for nursery coathanger. (Courtesy, Halex, Ltd.)

from any cavity. Under post-war conditions the powder shortage has a similar effect. Moreover, the fact remains that although people like to think that their moulds will stand up to hundreds of thousands of lifts, economic reasons make it imperative to increase the number of cavities as soon as larger quantities are required so that a job requiring 100,000 off would probably be moulded from a 10-impression tool, so that each cavity would still have to produce 10,000 pieces only, and results would not be very conclusive. In addition, the economic advantages of the process accentuate the tendency to put into production more impressions right from the start, thereby reducing the individual demands on each impression.

Generally speaking, multi-impression tools have been particularly prominent in demonstrating the advantages of the process, for even on shapes where it is doubtful whether a single-impression tool would still show the usual saving, bearing in mind the electro-forming cost as well, there is usually no doubt about the advantage in a multi-impression tool. The procedure is to make the first master, electro-form an initial cavity and then to mould the other masters at very little cost in acrylic material by methods that avoid shrinkage, and then to electro-form all subsequent cavities together, again at very little cost per individual cavity. The economic advantage thus obtained is often

striking. There are even some marginal cases where the first cavity is made by ordinary methods, sometimes in brass, and the masters moulded from this.

There are special cases where an individual sample of, for instance, a very intricate button is obtained from overseas, and this serves directly as a master for an initial cavity, later to be used to produce masters for a multi-impression tool. The use of phenolic, urea or thermoplastic mouldings as masters or parts of masters is technically feasible in many jobs not calling for great accuracy (double shrinkage).

Outlined above are the technical difficulties of obtaining reliable figures of runs. These are increased by psychological ones, as users are sometimes reluctant to testify about the good performance of a tool which they intend to use further as this might weaken their case should there be trouble during a later run and should they wish to claim free replacements, a claim which is generally granted (in cases of trouble after an unreasonably short run) at very little cost to the producers of the tool, as moulded masters are usually kept for record purposes.

After about five years of operational research the position, as ascertained in spite of the above difficulties, is as follows:—

INJECTION MOULDING.—The highest figure obtained from any one cavity is 170,000; many runs of the same magnitude have been reported. In each case the tool was as good at the end of a run as at the beginning. It appears that for injection moulding the hard nickel electro-formed tools are equivalent to hardened and polished steel tools as regards durability. In the few early cases where a minority of partial failures occurred, these were traced to the electrolytic shells having been pre-stressed owing to being pressed too tightly into the bolster in the desire to avoid flash retaining gaps.

COMPRESSION MOULDING.—Performances of 20,000 lifts per cavity have been reported without trouble to the tool.

TRANSFER MOULDING.—There is as yet insufficient experience, but it stands to reason that the performance here should be somewhere in between compression and in injection moulding. In fact, more experience in this field would be welcomed by the writer.

Other applications, such as pressing celluloid sheet, etc., have been carried out successfully without trouble having been reported. The same applies to extrusion moulding, where, however, electro-forming can only be justified economically for very intricate shapes. Die-casting experience is outside the scope of the present article. However, a very special application is worth while reporting, as it shows that sinking is not a likely danger in plastics moulding. This is the use of nickel electro-formed moulds for pressing pinions by powder metallurgy at pressures of 50 tons/sq. in. This was actually discontinued after a comparatively short run, not because of any sinking trouble but owing to excessive abrasion on the surface. Evidently cast-iron powder travelling under 50 tons pressure needs a hardened alloy steel surface.

A special field of application has been the manufacture of acrylic resin teeth mainly by compression moulding, in the special dough and powder methods which are used, but also by injection moulding. For this work the nickel-alloy moulds offer the following special advantages:—

(1) They are cheap compared to steel, particularly compared to stainless-steel moulds (chemical reasons call for a stainless surface, and nickel is satisfactory).

(2) A really long run can be obtained as opposed to the usual plaster moulds, or even compared to copper electro-formed or cast-bronze moulds.

(3) The customer can prepare his "masters" in a material most congenial to him, i.e., acrylic resin moulded in plaster-of-Paris impressions taken from the original teeth.

(4) The "master" is the direct medium on which the tool is electro-formed without any intermediate stages, so that the customer is sure of getting exactly what

he ordered, i.e., a dentist's and not a tool-maker's interpretation of teeth.

(5) If the "master" is of high standard the finished tooth mouldings do not require further polishing and have a very thin flash, which is vital in the economic production of acrylic resin teeth.

Tooth moulds of this type have been running day and night for a number of years without trouble; some of them at pressures of as much as 8 tons/sq. in.

Other fields where the process has found particular application are, first of all, the artistic and fancy lines, such as brooches, cameos and other decorative mouldings. The production of plastic cameos by electro-forming the tool direct on to a genuine one is a case of particular interest. An application where the decorative and the technical meet is the imitation of cut-glass; very easily achieved by milling the master in the appropriate manner, but very difficult to obtain by ordinary die-sinking methods. This applies equally to bicycle rear lamps and to imitation cut-glass table ware.

Among the more technical lines, electrical parts, particularly when they are small and intricate, such as used in "deaf aids," etc., show the process at an advantage. Moulds for the ear-pieces of deaf aids are another particularly suitable application, as they can be electro-formed direct on to acrylic resin masters prepared by a person of suitable medical qualifications to an anatomically correct shape.

All mouldings requiring sunk writing, arrows, etc., such as nautical and other scales, measuring instruments and slide rules, are another special field, owing to the ease with which such characters can be hand engraved on the masters, resulting in embossed script in the tool, even in the deepest part of the cavity. High-quality mechanical toys should be another special outlet.

When the development under review was first embarked upon, many regarded it as an alternative to conventional tool-making, and some indirect opposition was met with on this account. For this and other reasons (pressure of work on existing tool-rooms, 1942-45) it was not practical to limit the work to the manufacture of cavities only, and a fully manned and equipped tool-room was built up around the electro-forming work. This was not only necessary, in order to turn out anything at all, but also a boon to the development work, as it was soon found out that knowledge of the manufacture of the electro-formed shells had to be supplemented by that of machining and fitting the cavities owing to their unusual machining properties.

True to Lord Kelvin's words that "engineering leads to improvements, science to revolutions," the development of electro-forming technique has led to the possibility of turning out more and more cavity shells at a rate increasingly exceeding the capacity of the tool-room that has to digest them into complete moulding tools.

Thus the wheel has come to a full circle, and the next step should be the use of electro-formed cavities in tools—wherever there is a good case for their use—by tool-rooms generally, just as they use hobbed cavities. Even more than with hobbed cavities is it necessary to leave the actual manufacture of the cavity to the expert, but this should not militate against their adoption by designers and tool-rooms. This division of labour still leaves a vast amount of bolster, punch and ejector mechanism work, not to mention the assembly work, to the ordinary tool-maker, who will soon learn to realize that electro-forming is not a rival but yet another weapon in his armoury, as it is in that of the plastics industry generally.

THE DOW CHEMICAL CO., Midland, Michigan, U.S.A., announce that the company has formally released its trademark rights to the name "Saran," thus permitting it to become the descriptive name of the product. It is stated that this action has been taken "in the interest of simplifying identification on various plastic materials whose chemical names have for years been confusing to Press, trade and consumer alike." The term "Saran" is applied to a series of vinylidene chloride copolymers originally developed by Dow.

LETTERS TO THE EDITOR

Correspondents are reminded that a stamped and addressed envelope should be enclosed in all cases where a personal answer is desired. It is understood that any letter received may be published at the discretion of the Editor.

Plastics for Water and Gas Pipes

Sir,—We were interested to read in the February issue of "Plastics" of the use of p.v.c. for water pipes and also of "Tenite II" (cellulose acetate butyrate), a product of the Tennessee Eastman Corporation of Kingsport, Tennessee, U.S.A., for gas pipes.

"Tenite II" is widely used in the United States for water pipes, a specific example being for the sanitary and drinking-water fittings in the Boeing Planes. As it is completely non-toxic and has a low plasticizer content, prolonged immersion tests have shown no effect on the purity or potability of the water, or on the surface or physical properties of the plastic. Other applications are found in beer and mineral oil pipes, shatter-proof manometers, and irrigation siphons.

Tubing made of "Tenite II" is manufactured in Great Britain, but not by this company. We would be glad, however, of putting those interested in contact with sources of supply, at the same time providing them with specifications of the material in question.

KODAK, LTD. (T.E.C. Products).
Wealdstone,
Harrow, Middlesex.

Reinforced Plastics

Sir,—We have read with interest the informative monograph on Fabric Reinforced Plastics, by W. J. Brown, of The Bushing Co., Ltd. (Cleaver Hulme Monographs on Plastics). Useful data on the physical and some electrical characteristics of the reinforcing medium and the finished products are included and amidst the mass of published figures relating to plastics in journals and handbooks it is good to find, collected in one small volume, a series of comparative figures and results compiled and produced by one authority.

The writer would have been pleased to see included some few figures and tests relating to plastics other than the phenolic type when used in fabric bonding. Also it is noted that no reference is made to modified cellulosic fillers such as Cotopa, the acetylated fibrous cotton, for which enhanced moisture and fungi resistant properties and greatly improved electrical characteristics are claimed (see E. E. Halls, "Plastics," pp. 480 and 541, September and October, 1947, and British Patent No. 513,687 of British Thomson-Houston Co., Ltd.).

Perhaps as a mild criticism the paucity in general information on the electrical applications of laminated plastics is to be decried. This was understandable in wartime when its use in radar and other equipment was on the secret list. There must now be considerable data worthy of publication.

H. T. WALLINGTON,
Bradford. for Cotopa, Ltd.

Natural Raw Materials

Sir,—We have been greatly interested in your editorial, "Natural Raw Materials," in "Plastics," February, 1948. As our company has been for some time past and still is, the largest producer of tanning extracts, your reference to such natural phenolic compounds as quebracho and mimosa tannins was of particular interest to us.

We have made an extensive study of the possibilities of manufacturing water-softening materials on the basis of our own products and have extended the work also to the manufacture of moulding powders. After and almost simultaneously with the work carried out by the Department of Industrial and Scientific Research, which culminated in British Patents No. 465,411 and 481,819, we developed a small series of processes which were later on incorporated in British Patents No. 539,581, 545,157 and 567,495.

We also have read in your periodical

ing tool-rooms, 1942-45) it was not originally developed by Dow.

the series of articles written by Capt. F. J. W. Bartlett, under the title "Front Line Plastics," in your October and November, 1945, issues.

One reason for the halt noticeable in interest taken in these applications of tannins in other fields than tanning must be chiefly attributed to the world-wide shortage of tannins, the essential use of which is certainly in the manufacture of leather. With regard to quebracho, we should like to state that this tree grows chiefly in the Argentine Republic and in Paraguay. Occurrences in other parts of the world, e.g., in the Empire, are almost nil.

E. H. W. ROTTSIEPER,
Chief Research Chemist,
The Forestal Land, Timber and Railways Co., Ltd.
Harpenden, Herts.

Protective Coatings

Sir,—We are interested in the letter from A. A. Jones and Shipman, Ltd., which appeared in your February issue. We are manufacturers of a material which is very suitable for protecting tools against corrosion, and can be of considerable assistance to manufacturers who require either the material or technical information.

DOHM, LTD. (Plastics Division).
167 Victoria Street, London, S.W.1.

Water Filters

Sir,—We are making fittings for gas-boilers, and as we are, at the moment, using blotting paper to act as a filter for the outlet stream, this method is not very satisfactory. Can you advise us of a suitable material which will filter boiling water, preferably at slow speed? We could cut such material to fit a six-inch receptacle.

"LUSTERLITE" PRODUCTS.
Leeds.

[EDITOR'S NOTE: If it is required to filter suspended particles only, we suggest a pad of cotton wool or of asbestos wool. The first would have a comparatively short life, although much longer than blotting paper. The asbestos pad would have an almost infinite life, and, furthermore, could easily be cleaned and replaced; it would even withstand igniting in a hot flame to remove collected organic matter. Fine sand may also prove suitable. Depending on the job, such as removal of colour and odour in water, materials like activated carbon, bone charcoal, etc., may be employed, but do not seem applicable in this case, as replacement may prove difficult to arrange.]

Testing Plastic Leathercloths

Sir,—Can you inform us whether any specifications exist for the testing of plastic leathercloths as regards abrasion resistance, elasticity, peel of coating, resistance to cracking or flexure, resistance to acids and alkalis, etc.? If such specifications exist, from whom can they be obtained? SCIENTIFIC AND INDUSTRIAL DEVELOPMENTS, LTD.
Town Mill Brow, Rochdale.

[EDITOR'S NOTE: There is no specification for the testing of plastic leathercloths, although the British Plastics Federation is at present considering the matter. We suggest that you get into touch with Vinyl Products, Ltd., Devonshire Road, Butter Hill, Carshalton, Surrey, who are working upon such a specification.]

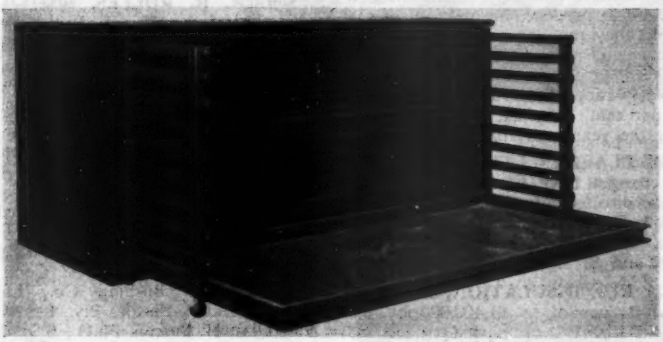
"Windolite"

Sir,—Some years ago there was on the market a plastic sheet called "Windolite," which consisted of some form of celluloid material moulded on to a fine metal mesh. I should be obliged if you could let me know whether this material is still being manufactured, and if so, who are the makers. L. ROTHERA.
Motherwell.

[EDITOR'S NOTE: Although we know "Windolite" quite well, we are afraid we have been unable to trace the name and address of the makers; we feel sure, however, that any large builders' merchant or horticultural sundriesman can supply. This material, however, is not made of celluloid but cellulose acetate, reinforced with a fine metal mesh. Its main use is not only for the protection of windows, but also for making garden cloches. There are on the market similar materials made by other firms, mostly for use as protecting guards in machinery. BX Plastics, Ltd., for instance, manufacture a strong type, also available for making hurricane lamp "chimneys." "Wireweld," a similar material, is made by British Celanese, Ltd.]

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes



STORAGE OF PLASTIC SHEETS.—Experience has proved that the safe and satisfactory storage of plastic sheets and veneers often presents some difficulty. With this in view, Fisher and Ludlow, Ltd., of Rolfe Street, Smethwick, Staffs, have designed the storage rack here illustrated. This rack, as a complete unit, measures 9 ft. 3½ ins. wide by 4 ft. 9 ins. deep by 4 ft. 4½ ins. high, and is capable of holding a total storage load of 4,000 lb. In its design a number of engineering problems had to be overcome, for each drawer has not only to safely carry a dead load of 400 lb. of material, but has to be capable of being fully extended so that the sheets may be lifted out without injury; at the same time the loaded drawers have to be carried by the general framework of the rack in such a manner that they may be pulled forth or returned quite easily by one man. These racks, it may be added, were first made to meet the particular needs of a well-known company operating in the plastics industry.

MELAMINE TEXTILE RESINS.—Aero Research, Ltd., and British Industrial Plastics, Ltd., announce that an agreement has been reached between Ciba, Ltd., of Basle, and themselves, whereby the full development in the field of melamine-formaldehyde resins according to Henkel's British Patent No. 455,008 and Ciba's British Patents including Nos. 468,677, 486,519 and 486,577, can now go forward in the textile industry. Licences have been obtained whereby they are in a position to manufacture and supply the necessary materials and to authorize their use for textile applications under the Ciba's British Patents, including Nos. 466,015, 477,841 and 482,345. Consequent upon these arrangements Aero Research, Ltd., and British Industrial Plastics, Ltd., are now in a position to offer these materials through their agents to the trade.

RENNET CASEIN PRICES.—The Director of Sundry Materials, Board of Trade, 10, Old Jewry, London, E.C.2, announces that as from February 2, 1948, the selling price of rennet casein is reduced from £210 to £160 per ton.

E. K. COLE, LTD., held their annual general meeting at Southend-on-Sea on February 12, when Mr. Eric K. Cole, chairman and managing director, presided. The company's products are now included under four main headings, one of which is plastics mouldings. According to the chairman's statement, the Plastics Division has been steadily forging ahead, and now manufactures a large range of industrial and commercial products for all trades, including the automobile, electrical and general engineering industries; building and furniture; fancy goods and toys. All these varied products have been very well received. In addition, the Plastics Division continues to produce radio cabinets and other components for the

company's own use and for other radio manufacturers. During the past year a thermoplastic plant has been installed and the company is confident that this will be a very valuable adjunct to their existing thermosetting plant. In order to give better service to customers, the tool room has been extended and the Plastics Division is now able to produce the majority of the dies which they require.

The company's report and accounts for the year ended September 30, 1947, were unanimously adopted, and the final dividend of 14½ per cent., less tax, making 22½ per cent. for the year, was approved.

CLYDE PLASTICS, LTD., announce that certain changes have taken place on the board, the directors of which are now Lord Westwood, Douglas M. Hannah (managing director), Col. Alex. G. Young, Richard Beecham and B. S. Feldman.

DE LA RUE INSULATION, LTD., has increased its capital to £1,400,000 by the creation of 1,200,000 ordinary £1 shares.

THE PERMUTIT CO., LTD., has commenced production at their new factory at Pontyclun, near Cardiff, where ion exchange materials of all types are to be made, including the new synthetic resins which were originally developed by the Department of Scientific and Industrial Research in 1935.

CALEDONIAN PLASTICS, LTD., have been appointed sole distributors in Scotland for Scottish Plastics, Ltd., and Lanarkite, Ltd., with offices and showroom at 12, Renfield Street, Glasgow.

MONSANTO CHEMICALS, LTD., announce that Mr. S. E. Chaloner, M.Sc., has been appointed industrial relations officer to the company; he will operate from London. It is also announced that a Central Engineering Department has been formed within the company, and will be located in London. Under Mr. W. M. Cooper, as manager of engineering, the new department will have separate divisions covering chemical, mechanical, civil and constructional engineering. Mr. M. Buis, B.Sc. (Delft), will be head of the chemical engineering division; Dr. J. A. Gardner, A.R.I.C., as assistant chief chemical engineer (Ruabon), will operate a section at Ruabon. Mr. O. W. Murray, M.I.Mech.E., M.I.Chem.E., will be chief mechanical engineer, and Mr. R. Adams, B.Sc., A.M.I.Chem.E., chief civil engineer; and Mr. W. M. Kershaw, B.Sc., A.M.I.Chem.E., will continue to act as chief construction engineer at Newport, where Monsanto are building a new plant.

WOKINGHAM PLASTICS, LTD.— Mr. A. Hooker has resigned his appointment as sales manager of the Triplex Safety Glass Co. and has now joined Wokingham Plastics, Ltd., as technical sales manager, operating also on behalf of their associate company, G.P.A. Plastics, Ltd.

MR. R. R. ROLLES, B.Sc., A.R.I.C., acting chief chemist of British Moulded Plastics, Ltd., has now been appointed chief chemist.

THE PLASTICS INSTITUTE has announced the election of the following Fellows and Associates:—FELLOWS: G. E. Haefely, Dr. Ing. (Darmstadt), consultant; N. J. L. Megson, B.Sc., M.Sc., F.R.I.C. (Ministry of Supply); M. H. Benoliel, B.Sc., A.M.I.Chem.E., F.C.S. (Attwaters and Sons); C. J. Goodwin, B.Sc., M.I.Chem.E. (consultant); W. J. Brown, B.Sc., M.I.E.E. (The Bushing Co., Ltd.); W. A. Cook, B.Sc., M.I.E.E. (The Bushing Co., Ltd.); N. Fienberg (A.C.I. Plastics Pty., Ltd., Victoria, Australia); H. Barron, Ph.D., B.Sc., F.R.I.C. (consultant); C. Lockstone (O. and M. Kleemann, Ltd.); J. Veit, A.M.I.E.E. (Duratube and Wireless Ltd.).

ASSOCIATES: A. Lewin, B.Sc. (Preformations, Ltd.); P. Robitschek, B.Sc. (Prague).

NOTES FROM BRITISH PLASTICS FEDERATION

Annual General Meeting

The annual general meeting of the Federation has been arranged for March 16, at 11.45 a.m., at the Federation Offices.

New Members.—The following have been elected to membership of the Federation:—

PLASTICS MATERIAL MANUFACTURERS' GROUP

The Greenwich Leathercloth Co., Ltd.

Wallington Weston and Co., Ltd.

MOULDERS' GROUP

E. and T. Plastics, Ltd.

Richglaze Plastics, Ltd.

ASSOCIATE MEMBERS

Parco Industries.

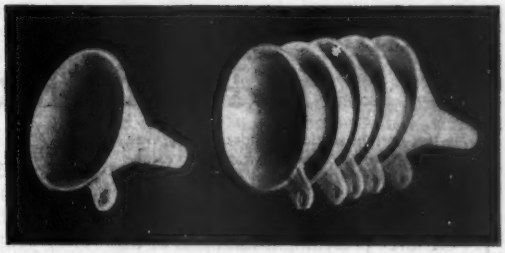
Moulders' Group.—A very successful buffet dance was held at the Dorchester Hotel, at which over 200 were present.

Federation Publications.—The following publications, recently issued, are available at the price indicated:—

No. 18.—"Moulders' Section, Report of the Sub-committe on Costing." 4s.

No. 21.—"Proposed Standard Methods for the Determination of Loss in Weight on Heating and Solid Resin Yield of Synthetic Resin Materials, and Proposed Standard Methods for the Determination of the Viscosity of Synthetic Resins." 2s. 6d.

New Productions from the Moulding Shops



Polythene Funnels

These funnels, made of polythene by Tamworth Plastics, Ltd., of Alders, Tamworth, Staffs, can be used in filling bottles with liquids of acid character; indeed, for contact with corrosive chemicals of various kinds. When handling medicines they have the advantage of being able to be sterilized by aid of boiling water.

Desk Calendar

The 1948 desk calendar distributed to their friends by Bowater Paper Corporation, Ltd., took the form of 53 weekly cards fitting into a polished black plastic stand. The stand is moulded in black general-purpose wood-filled phenolic resin, by British Moulded Plastics, Ltd., and is set at a convenient angle for observation when on the user's desk.

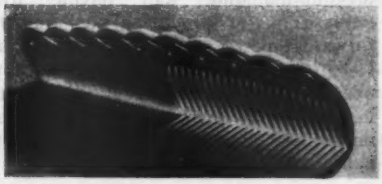
The cards were printed by De La Rue Stationers, Ltd., and have a special cellulose waterproof finish applied to both sides to prevent any possibility of set-off; they are finished with rounded corners and gilt edges. Each card includes a photogravure picture of one aspect of the Bowater activities. The complete article presents a high standard of British craftsmanship and is a successful combination of moulding and printing.

Soap Dispenser

Apart from its nickel-plated nozzle and pivots, this tip-up soap dispenser is fabricated wholly of "Perspex." The container, half clear and half opal, is in one piece. The manufacturers are Glaz-Lite, Ltd., 140, Hoxton Square, London, N.1; sole distribution agency, New Hygiene Co., 266-268, Holloway Road, London, N.7.

Improved Comb

The teeth of this comb, injection moulded in cellulose acetate (also polystyrene), are specially strengthened to resist breaking off; they have a so-called "buttress" form or cross-section substantially thickened near the base of the tooth. The makers are Milex Star Engineering Co., Ltd., Kirkby Trading Estate, near Liverpool.



Quality Control in Plastic Moulding—IV

In this present section consideration is given to the steps to be taken to initiate and establish quality control methods of inspection upon the component production from a portable manually operated compression mould.

By W. M. HALLIDAY

IN the three preceding instalments of this series attention has been devoted mainly to the underlying principles and the statistical basis of quality control methods of component checking. Explanations were given of the manner in which control charts were derived, constructed and employed. Whilst such descriptions were necessarily abbreviated, and in some parts perhaps over-simplified for the sake of clarity, it is hoped that readers will have gained some insight into the many ways in which such a system may successfully be utilized by the plastic-moulding engineer. Thus far, however, only the simplest and briefest mention has been made of an actual application, and it will, perhaps, serve an extremely useful purpose in making more plain the entire way in which the system is applied if an actual case be now considered in detail.

As will be described later in this series, there are many complex variations of the system to meet complicated sets of production circumstances, but unless the applications of quality control principles in their very simplest form are clearly understood it will be more difficult for readers fully to appreciate the possibilities and value of the method. For such a purpose the author has selected a simple type of compression-moulding job. This comprises a portable compression-moulding tool having five impressions for producing the straightforward type of plug component shown at Fig. 1. This mould is of the manually operated kind; that is, loading, mounting on the press, moulding, cure, unloading, etc., all are performed by hand.

From the drawing of the moulded article it will be observed that close control has to be maintained over the outside diameter, the diameter of the bore and the size of the recess formed at one end. It was also necessary to hold the components to a given standard of surface finish, so as to ensure that they be free from flow marks, blisters, bubbles, sinks and all the other minor snags which are usually associated with plastic-moulding production. Each moulding was also required to be up to a given standard of solidity, i.e., free from porous spots, etc.

Whilst the limits set down for the variations in the dimensions already mentioned are not as fine as can be obtained consistently from compression moulding, it was judged with this type of mould and its method of operation, i.e., hand operated, that these limits could easily be attained without undue trouble and stringency upon the various phases of the process.

Incidentally, there arises at the outset an important query which the author desires to answer. It is very often said by production engineers and inspectors that quality control techniques and methods are, perhaps, excellent when applied to operations of a purely auto-

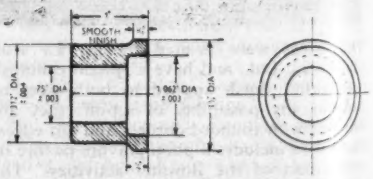


Fig. 1.—Drawing of Moulding Component, showing the various dimensions to be controlled to limits indicated.

matic nature, as performed by a machine whose every movement can be very accurately predetermined as to duration, correctness of function, quality and general effects as reflected in the finished product.

When attempts are made to apply the system to purely manual or hand operations, however, a completely different set of operating factors has to be dealt with. It is notoriously exceedingly difficult to control such an unpredictable factor as the human element, hence there is the widespread belief that quality control cannot be effectively employed for this latter type of operation.

It is hoped that one of the most salutary objects which this present article will accomplish is precisely to provide an adequate answer to this criticism and to show that the system is equally applicable and useful to such operations. As will be seen later, adaptations have to be made to the usual form of control means in order to suit the peculiar requirements of this purely manual operation.

In compression forms of plastic moulding the purely hand-operated type of mould is in very extensive use, and one of the chief endeavours of the author in selecting a typical hand-operated mould is to show that the above objections are capable of being effectively overcome by simple modifications to the usual quality control procedures as described in earlier sections. It is hoped to prove that, whilst the variable factors associated with use of purely manual types of tools of the kind about to be considered are numerous, and admittedly often very awkward to deal with, they need not necessarily be regarded as insuperable.

Kind of Hand Operations to be Considered

In connection with our example mould, one of the first things to establish, preliminary to setting up quality control, is the accurate predetermination of the exact nature and extent of all the purely hand movements involved throughout a moulding cycle. Unless a very close analysis is made of these movements at the outset it will be rendered far more difficult to install controls of a satisfactory kind, since it will be impossible to know whether or not any particular hand movement is necessary or whether it is being properly and efficiently performed.

One other purpose of such a check will be to ascertain any possible time- and effort-wasting movements which can be modified, or even eliminated, without retarding the speed or effectiveness of the moulding sequence. This will, in itself, be an extremely important point, because if it achieves no other purpose than to uncover wasteful, unnecessary or unreliable forms of handling of a moulding tool, etc., this will often prove to be invaluable. It will also suggest ways and means whereby such wasteful movements can be avoided, likewise promoting improved handling of the tool in general.

In actual practice it will often be found, upon making such an examination, that much of the trouble, low rate of production, wear and error in moulding tools, inaccuracy of the finished products, in the case of a portable manual-type mould in particular, are due to mishandling or omissions and faults connected with the operator. Obviously, the elimination of all such undesirable or wasteful activities should be secured before instituting quality control, although the variations they give rise to in respect of the finished mouldings will be plainly indicated upon the control charts as production proceeds.

Reverting now to our example, what are the chief hand movements present in the manipulation of this tool? In actual practice they will comprise the following:—

(a) Cleaning of the mould in readiness for receiving a further charge of moulding powder.

(b) Measuring off the powder charge.

(c) Placing powder into the mould cavities.

(d) Closing top tool on the mould, seeing it is correctly positioned on the dowels.

(e) Cleaning external surfaces of the mould in readiness for insertion into press daylight.

(f) Cleaning platen surfaces and seeing that all is in readiness on the press for taking the mould.

(g) Placing mould into position on the platen.

(h) Locating the mould correctly thereon.

(i) Checking steam flow and mould temperature.

(j) Closing press and curing.

(k) Opening the press.

(l) Extracting of mould and transfer on to unloading table.

(m) Removal of top tool.

(n) Extracting the moulded articles.

(o) Cursory examination to detect unwelcome flash, ripples, flow lines, imperfections of any visible kind.

These are the essential hand movements usually occurring with this class of mould. However, there may be a number of other operations actually effected by the operator, many of which are superfluous and useless so far as the main objective of moulding is concerned. Thus, he may search for unwanted tools, manipulate the mould in the wrong manner or out of sequence, attempt to lock up the wrong screws, fail to tighten the proper ones, and so forth.

Undertaking such an examination, it should be one of the chief objects of the moulding engineer to reach the position that he knows every essential hand movement required, their proper sequence and relationship to each other, and the amount of time taken to accomplish them. Once the absolute minimum number of these essential hand movements has been ascertained, each should be carefully timed as well as checked, to ensure that it is being performed as efficiently as possible.

Such timing and checking should of course, be carried out over a large number of moulding cycles; if conducted on only a few of these operations, a completely false result may be obtained, due to failure to include and cover unusual snags, delays, oversights, etc., which are normal to the job.

This examination will also indicate to a large extent the nature of the difference between automatic machine operations and manual ones. It will reveal that variations in time taken to produce the components over successive batches or pulls, as well as many of the variations in the features or dimensions of the parts to be due to the shortcomings on the part of the operator rather than the setting or the accuracy of the mould. In fact, this is one of the characteristic features to be noted of the comparison between control means for hand and automatic machine operations. The different cause for the variations in the finished product is extremely important to note, because, as will be explained more fully later, it entails a somewhat different interpretation being given to control charts for such activities.

The ranges of the sample sizes from a purely automatic operation will very often vary but little. It is the plotted points on the other chart of sample means which tend to exhibit the biggest variation. The products from the automatic machine operation will be maintained for a reasonable period within uniform limits of variation, these being exceeded only as a result of tool wear or departure from original correct setting of the tools and machine. As explained in the last section, should the range chart show variations located within the appropriate datums, nothing serious is occurring. But should the range chart show tendencies to get out of control, then something very serious is amiss as it indicates some breakdown or fault in the fundamental operating sequence of movements of the machine and will most probably entail a repair or overhaul, as distinct from merely

adjusting a setting point, as necessary when the mean chart shows variations.

With a purely hand-operated kind of moulding activity the position is different. The chart of sample means based on the characteristic of the job will still be employed, in somewhat the same fashion as previously described, but the chief sources and scale of errors observable in the finished product will be attributable to the shortcomings of the operator in his performance of the required manual operations.

These are the main sources of error likely to be met with, hence the importance in hand operations of the range chart. The shortcomings and errors will generally be of a sporadic and random kind, consisting of such things as too long a dwell of the press in the closed position, so affecting the length of cure; failure to keep the mould and platen surfaces scrupulously clean; lack of care in handling the mould when placing it upon, or withdrawing it from, the press or unloading stand; an improper setting-up prior to taking pulls; damage inflicted by careless and thoughtless handling, and a variety of other odd, erratic actions arising from the lack of interest, experience or concentration of the operator.

These factors and influences will always be present and it is doubtful if any purely hand operation could be devised where they are completely absent because of the human element. The purpose of setting-up quality control is to indicate tendencies towards such errors as they develop during production, so that corrective action can be taken sufficiently early to prevent the manufacture of large quantities of faulty workpieces.

Basis of Control

The next important step to be taken with regard to the moulding example being analysed is the determination of the correct basis of the proposed controls. As with most plastic mouldings, a number of features usually have to be held within specified limits or standards. In this particular instance they are three in number: First, three of its dimensions have to be held within given drawing limits. Secondly, its weight has to be maintained within a given scale of variations to ensure that fully formed and sound mouldings are produced. Thirdly, the surface finish has to be kept to a reasonable degree of smoothness, evenness and quality.

Concerning the first point, this is capable of considerable variation due to vagaries of the operator when handling the mould, or committing errors, faults, oversights, omissions, etc., of the kind just enumerated.

Providing that the mould is kept properly adjusted and is used generally in accordance with the previously determined sequence, dimensional variations can be kept within the limits laid down. This, taken in conjunction with the fact that the specific gravity of the moulding-powder material remains constant within reasonable small limits of variation, means that the weight of the finished moulded article affords a reliable indication of its bulk density and degree of homogeneity. The finished mouldings, therefore, have to be checked and inspected mainly to detect variations in respect of these three features, and the next step is to set up provisions whereby such checking can be economically accomplished.

Dimensional variations would be checked by means of suitable gauges supplied to the operator or inspector who has to compile the control chart.

To determine the weight of components during their production, there would have to be introduced some reliable means for weighing the parts as required. This would also become a recognized duty of the inspector in the same manner as using the gauges to check dimensions.

The quality of the surface finish will be determinable by reference to a previously selected sample moulding, which has expressly been chosen for reason of being entirely satisfactory in respect of

efficiently as possible.

or overhaul, as distinct from merely

its surface finish. Such a sample would be plainly indicated, to identify it from any other normal moulding, so that no mistake could be made during an inspection.

With regard to the weight of the moulding, it must be pointed out that minimum and maximum figures should be given to the inspector. Preferably such figures should be denoted plainly on the dial of the scale or weighing appliance, so that doubt is eliminated from the weighing operation. Some decision will also have to be made respecting those mouldings on the borderline of minimum weight. There must be no question of an inspector deciding that this moulding can be passed although it is only ½ oz. under minimum weight. A rigid ruling covering such a point must be laid down during the initial stages.

The same remarks apply to the non-measurable quality of surface finish. Here reliance has, of necessity, to be made to the powers of trained observation and to the general intelligence of inspectors.

At the commencement of control being exercised in moulding production it will be advisable to make a consistent 100 per cent. check for dimensional errors, weighing for density, and comparison with approved sample to assess agreement with its surface finish. Such a 100 per cent. check need not be maintained beyond the part where production is stabilized, with the operator working to the correct sequences, etc., all of which will be depicted by plotted positions on the control charts being used. Beyond this point it will be necessary for the inspector to spend only a short time each hour, sufficient to check the measure, and to weigh four or five components, and to plot these results upon the quality control charts. The remainder and bulk of the production during the period can then be passed as being to the required standard.

When a plotted point takes place *outside* the control lines, all the parts produced since the previous inspection should then be isolated and given a 100 per cent. inspection on every component. Coincident with this, the control chart will already have given an indication that something untoward has occurred in the production conditions causing the variations in the finished product.

Objections to Suggested Control Procedure

This, then, is the basis of the control to be set up, and before proceeding to describe the necessary control charts for the operation it will be well to anticipate one or two objections likely to be offered.

The first of these will be relating to the lack of solidity of a moulded article. It will be pointed out that a certain minimum amount of porosity may have to be permitted, resulting in a reasonable amount of variation in the weight-control figures, because rarely is it possible to obtain in regular production consistent 100 per cent. sound mouldings.

It will be averred that even such slight permissible lack of density may cause serious objections, because on many moulded products it is the exact disposition of such porosity, rather than the extent, which creates the chief difficulty. This is perfectly true, and with certain precision-type mouldings may constitute a major snag. To overcome them may mean the inauguration of special tests on both the finished mouldings and the moulding process in order to maintain uniformity.

The control charts provided for the work, however, will definitely enable the *general quality and accuracy* of the finished components to be held at a reliable level well within the drawing specifications. This will be secured because, as the charts are compiled coincident with the production run, they will immediately demonstrate any significant and appreciable variations which occur. Such variations, moreover, will be depicted on the charts as tendencies towards a given undesirable feature thus

to be held within specified limits or being entirely satisfactory in respect of

readily indicating to the inspector and mould setter what is occurring.

Of course, where the uniform density of a moulded product is of vital importance and required to be held within close limits it will be essential at the outset of production to ensure that the minimum weight decided upon for the guidance of the inspector represents the requisite standard of quality and soundness. This figure should preferably include a reasonable margin, in the region of 10 per cent. above the weight of a moulding within the standard of density required.

For such a purpose, if desired, this standard could be obtained by subjecting a suitably large and representative batch of mouldings to an X-ray examination, and from the results a very accurate calculation could then be made to ascertain the ratio of solidity in relation to the specific gravity of the material (which can be maintained uniform) and the volume of material composing the part.

A second objection which may be raised is that it will be somewhat difficult to effect control over the surface-finish features, since these are obviously less tangible and concrete than other features which can be measured, gauged or weighed. It will be urged that, to a large extent, this matter will depend upon the personal judgment of the inspector, with the result that, from day to day, if not hour to hour, his decisions as to acceptable or non-acceptable surface-finish quality may vary.

The answer to this is that any such personal judgment will be largely ruled out because the inspector will be provided with a sample of the finish desired, which he will use for *comparing* with the finish of the articles being produced. Thus, he will not have to decide whether or not any given finish will suffice, but rather whether or not it agrees with his standard sample piece. If it does, he passes the part; if not, he rejects it and plots the appropriate point on the charts. It should, of course, be understood that, in the case of a borderline item where he is doubtful, he should regard the item as outside the requisite standard, plotting the chart accordingly.

The charts will also illustrate the tendencies taking place in respect of this feature of the component, which, taken in conjunction with, say, an increasing percentage of borderline instances, will show at once that some significant change has taken place somewhere in the production cycle and therefore demands attention.

If such tendencies are immediately followed up (and naturally during the initial stages of a production under such a form of control instructions would be issued that this occurs) prompt examination of the mould, press or moulding methods would be made. In 90 per cent. of the cases some minor snag would probably be revealed, which upon correction would immediately restore the production sequence to its original standard.

In addition, it should be pointed out that, to assist the inspector still further, simple contour gauges could be supplied, by means of which it will be possible to check up quickly and easily the external shape of a moulded part to test for flatness, evenness, etc. Fortunately, most of the surface blemishes occurring on a compression moulding are plainly discernible and so would scarcely be overlooked by an inspector who had been specifically instructed regarding what to look for and guard against.

Generally, for any class of quality control over a moulding production it is essential that proper gauging and measuring equipment be provided for the use of the inspector. Failure in this respect, whilst not only slowing up the actual checking and gauging operations, may also lead to the passing of defective parts, which will cause the system of control to become discredited if the reasons for defectives are not tracked down to such a source.

The writer could furnish several instances where quality control has been applied to a job in conjunction with which the most indifferent gauging equip-

ment and methods were employed, inevitably leading to unsatisfactory control. This, in some instances, unfairly resulted in a loss of favour of the control system.

In this connection, therefore, it is very strongly urged that the production engineer be confident at the very outset of production to be controlled in this manner, that the best and most accurate and easily applicable gauging tools have been provided. It is also equally important that the inspector be specially instructed in the proper use of all gauges right at the beginning and, if possible, some indication given him of the possible snags likely to arise.

A further safeguard against the foregoing troubles becoming serious is to see that the mould setter and operator are fully conversant with the kind of commentary the control charts afford concerning production progress. Given an operator who has been trained to interpret the meaning of the control and range charts, valuable assistance can often be recruited. Once he understands the meaning of these charts, this fact alone will conduce in no small measure towards steadier and more uniform production activities, because the operator will speedily realize and appreciate the *effects* of any slight modification in method, timing or handling of the mould he might unwittingly make.

Rightly considered, with such hand operations being controlled, the charts will serve to indicate the variations of the human factor involved in the operation, as against the purely mechanical ones. This aspect of the system should preferably be well understood by all concerned, so as to ensure the maximum degree of co-operation between mould operator, setter and inspector. In this way many of the minor snags and variations which occur with hand-operated moulding operations not quality controlled will be eliminated simply by the fact that introduction of control charts very plainly illustrate *when* and *how such variations occur.*

Having cleared the foregoing queries and objections likely to arise in connection with a moulding operation of the kind under consideration, we come to the task of gathering the requisite data prior to building up and establishing the necessary control charts for the job.

Our first task is to ascertain, by sample tests and calculations, the control limits required to meet the working conditions under which the mouldings shown at Fig. 1 are to be produced. Particular note will have to be made as to where such limits have to be situated on the charts in relationship to the stipulated drawing limits.

Collecting Data for the Control Charts

To commence with the collection of this production data, sample individual components are taken in groups of five, consecutively as they issue from the mould, when the latter is being operated according to normal predetermined procedure. The intervals between taking such sets of five-unit sample pieces may be varied to suit the convenience of the inspector at this stage. One good plan is to take such a sample group of five mouldings at every third pull of the mould; that is, say, at intervals of about 25 mins. No hard and fast rule exists on this point, though the closer the drawing limits are (that is, the smaller the permitted dimensional variation), the more frequent the number of trial sample groups to be taken as a preliminary to constructing the charts.

Each sample set of five components, as taken from the mould, would then be subjected to the following procedure:—

(a) Ascertaining the dimensional variations on each of the three points required as described earlier; each single component should be carefully measured at these points, then weighed and, finally, compared with the known standard piece for surface finish. Each single component value thus derived is termed in quality control language as the sample X.

(b) Values X, in each set of five samples, are then added up and divided

SAMPLE X AVERAGES												
	SAMPLE GROUP	1	2	3	4	5	6	7	8	9	10	GRAND AVERAGES $\bar{\bar{X}}$
A	OUTSIDE DIAM. 1·312" ± ·004"	1·3125 1·3150 1·3090 1·3110 1·3080	1·3085 1·3095 1·3160 1·3140 1·3155	1·3095 1·3110 1·3105 1·3155 1·3165	1·3080 1·3115 1·3070 1·3080 1·3085	1·3140 1·3135 1·3090 1·3080 1·3155	1·3110 1·3115 1·3090 1·3080 1·3070	1·3110 1·3080 1·3155 1·3135 1·3175	1·3150 1·3165 1·3125 1·3140 1·3145	1·3115 1·3145 1·3125 1·3155 1·3085	1·3105 1·3070 1·3100 1·3085 1·3070	$\frac{1+2+3+4 \cdots + 10\ \bar{X}}{10}$
	AVERAGE $\bar{X}$	1·3111	1·3125	1·3126	1·3086	1·312	1·3095	1·3131	1·3165	1·3125	1·3086	1·3117
B	HOLE DIAM. ·750" ± ·003"	·7480 ·7475 ·7490 ·7570 ·7520	·7470 ·7460 ·7465 ·7510 ·7525	·7490 ·7520 ·7505 ·7515 ·7495	·7470 ·7505 ·7480 ·7475 ·7535	·7535 ·7495 ·7525 ·7510 ·7470	·7485 ·7520 ·7515 ·7490 ·7475	·7475 ·7480 ·7505 ·7510 ·7530	·7480 ·7495 ·7470 ·7460 ·7515	·7470 ·7475 ·7495 ·7505 ·7465	·7495 ·7525 ·7535 ·7515 ·7505	
	AVERAGE $\bar{X}$	·7507	·7506	·7505	·7492	·7507	·7497	·7500	·7482	·7480	·7515	·749
C	RECESS DIAM. 1·062" ± ·003"	1·0650 1·0640 1·0635 1·0625 1·0595	1·0615 1·0595 1·0625 1·0600 1·0585	1·0625 1·0630 1·0580 1·0570 1·0595	1·0580 1·0640 1·0595 1·0610 1·0635	1·0590 1·0630 1·0620 1·0575 1·0580	1·0600 1·0570 1·0580 1·0585 1·0615	1·0640 1·0600 1·0580 1·0620 1·0595	1·0645 1·0650 1·0665 1·0635 1·0575	1·0625 1·0635 1·0650 1·0570 1·0575	1·0590 1·0585 1·0560 1·0605 1·0645	
	AVERAGE $\bar{X}$	1·0630	1·0606	1·0600	1·0592	1·0598	1·0590	1·0607	1·0630	1·0611	1·0597	1·0606
	RANGE OF VARIATION OF X											$\bar{R}$
A		1·3150 1·3080	1·3160 1·3085	1·3160 1·3095	1·3115 1·3070	1·3155 1·3080	1·3115 1·3070	1·3175 1·3080	1·3165 1·3125	1·3155 1·3085	1·3105 1·3070	
	R	·0070	·0075	·0065	·0045	·0075	·0045	·0095	·0040	·0070	·0035	·0062
B		·7570 ·7475	·7525 ·7460	·7520 ·7490	·7535 ·7470	·7535 ·7470	·7520 ·7475	·7530 ·7475	·7515 ·7460	·7500 ·7465	·7535 ·7495	
	R	·0095	·0065	·0030	·0055	·0065	·0045	·0055	·0055	·0035	·0040	·0054
C		1·0650 1·0595	1·0625 1·0585	1·0630 1·0570	1·0640 1·0580	1·0630 1·0575	1·0615 1·0570	1·0640 1·0580	1·0665 1·0575	1·0650 1·0570	1·0645 1·0560	
	R	·0055	·0040	·0060	·0060	·0055	·0045	·0060	·0090	·0080	·0085	·0063

Fig. 2.—Illustrating the method of tabulating all data taken from sample check preparatory to making control charts.

by five in order to elicit the "average value," which is known as $\bar{X}$. Three such values will, of course, be obtained, one representing the outside diameter, one for the diameter of the bore and the last for the recess diameter.

(c) The above operation is repeated faithfully 10 times, taking this number of sample groups, or in all 50 single moulded components, checked at intervals of 25 mins., as previously mentioned.

(d) This being satisfactorily accomplished, the next stage is to calculate from the values in hand the "grand average," known as $\bar{\bar{X}}$ of all the 50 values. This may be secured either by taking all 50 individual measurements X, adding them together and dividing by 10, or by taking the mean of the 10 average values $\bar{X}$.

As will be appreciated in the case of a moulding of the kind under consideration, i.e., having a number of dimensions, etc., to be checked and eventually controlled, this task of collecting and dealing with the data may assume difficult proportions unless a proper tabulation is made of the individual results as they are obtained.

Such a table is shown at Fig. 2, where it is seen that all the above-mentioned values, averages, etc., are set out in proper order, as a result of which the task becomes greatly simplified. In addition, all the information required can be compressed into small compass and retained for reference purposes throughout the production life of the mould. This latter facility, incidentally, is a most desirable and useful one, because very often a subsequent use of a mould is characterized by unwelcome variations, and the inspector and production engineer may often find it helpful to be able to look up the original calculations made for the construction of the control charts.

Glancing briefly at Fig. 2, it will be

observed that the table is provided with 10 numbered vertical compartments under the heading "sample X averages." Three horizontal divisions are provided alongside the reference letters A, B and C, shown on the extreme left-hand side. Each of these letters represents one of the dimensions on the component which has to be controlled. Thus, in this present instance A is the 1.312-in. outside diameter, B is the 0.75-in.-bore diameter and C is the 1.062-in. recess diameter. The individual measurement of the sample component is then inserted into the appropriate column, these being in sets of five in each case, since that is the number of samples in a group.

Immediately underneath that space is another one running horizontally, wherein can be inserted the "average value" ($\bar{X}$), as indicated in the left-hand column heading. At the extreme right-hand side of the table a vertical spacing, or set of spacings, is provided under the heading "grand average" ($\bar{\bar{X}}$), these figures of 1.3117 for A, 0.749 for B and 1.0606 for C being inserted into the spaces immediately opposite the 10 average values ($\bar{X}$).

Where a greater or lesser number of features or dimensions have to be dealt with, the table would be appropriately compiled with the required number of horizontal compartments in the manner illustrated.

The lower portion of this table will be explained later, since this deals with the tabulation of information required for ascertaining data for the range chart. The information given in the upper portion of the table is for the purpose of ascertaining the control mean chart.

The next stage is to determine from the 50 individual measurements (upper part of table, Fig. 2) the scale of their variation or range value (R). This essential and very important value is derived by first subtracting the smallest individual measurement from the largest of the five items given in each of the 10 vertical spacings. This information is shown tabulated alongside each measurement (A, B and C respectively) and immediately underneath each sample-group number on the lower portion of the table seen at Fig. 2.

From R we calculate the average value ($\bar{R}$) by adding the range R of all the 10 groups and dividing by 10, which, in this instance, gives the following figures: A, .0062; B, .0054, and C, .0063. These values are shown at the extreme right-hand side of the table (Fig. 2).

It will be observed that all these measurements are taken to four places of decimals. The reasons for this are that, in the first place, we must remember we are dealing finally with averages of such figures and if they were calculated only to three or two places of decimals the ultimate result might be extremely erroneous when translated into the positions of the datums on the control charts. Secondly, the closer the drawing tolerances required on the component, the finer must be the measurements of the dimensions, otherwise, again because of the average values finally used, considerable error might be introduced into the calculations for the control lines.

At this point it will be advisable to interpose a short comment respecting the number of dimensions or features to be catered for on a moulding. With such a moulded article as shown at Fig. 1, and to which consideration has been restricted throughout this section, several courses may be taken for providing appropriate datums on the control charts. Obviously, it would be unwise to have sets of upper and lower control limits for *each dimension* on the same chart, because that would entail too large a number of control lines to make for clarity or effective use of the chart. As to which of three different methods may be adopted, the decision is largely determined by the degree of precision of the tolerances laid down by the drawing.

The first method is as follows: Should the component drawing tolerances permit reasonably wide latitude on every dimension, as in the example being dealt with,

which are all well within the capacity of the mould to produce, then the smallest or closest tolerance only need be considered.

In such circumstances, if a control chart is made up based on such a single tolerance and the production is controlled to bring all mouldings within that limit, the others will automatically fall within the requisite drawing tolerances. Thus, only one pair of datums representing these smallest datums will be required. This is the course followed with the example of the moulding now under consideration. Provided average figures are taken of all single sample component dimensions, duly averaged out in the manner described earlier, a sufficiently satisfactory result should be obtained. The inspector, in his periodic checkings during a proper production run, would, of course, measure all three dimensions to ensure they were within the stipulated tolerances.

If drawing tolerances are of a much more stringent nature than those indicated (Fig. 1), which sometimes happens, the second, and more reliable, method would be to take a mean of all the grand average values contained in the right-hand panels of the data table (Fig. 2). By doing so, a somewhat lower average figure would result, which, when employed in the subsequent calculations for ascertaining the relative positions of the control datums to be explained later, would give a slightly closer spacing to these lines and, therefore, a reduced degree of permissible variation in the component sizes.

The third method, which, admittedly, is the one most accurate, would be to construct a threefold chart with each portion being so arranged as to deal with one important measurement of the component.

This course would, naturally, be adopted only in those cases where the drawing dimensional tolerances were particularly fine and required to be rigidly maintained. Its chief drawback is that it entails an appreciable increase in the amount of time and effort required to compile the chart throughout production. This arises because the visiting inspector (after making his regular checks) would be compelled to make three times the number of plottings on the threefold chart than is necessary with a single type of the kind just intimated. Yet in some circumstances such additional time and effort expended on the chart may prove well worth while.

All the data essential to construct the control and range charts for this moulded component have now been derived and properly tabulated in readiness for making the calculations involved. It merely remains to ascertain the respective values and relationship to each other on their respective charts, and also their relationship to the drawing tolerances applicable. The positions of these latter, as datums on the charts, will also have to be correctly determined.

(*To be continued.*)

Book Review

Packaging and Display Encyclopædia, 1948. Pp. 880. George Newnes, Ltd. 63s. net.

This is an excellent compilation; the publishers, Mr. E. Molloy (general editor), the advisory panel, and the contributors deserve much praise. It is high time that the vast packaging industry (which means not only raw material manufacturers and machine manufacturers, but also everybody who sells or transports anything) possessed a complete guide. It is contained in this book, which is not only encyclopædic in size and contents, but is also excellently printed. To give an example of its scope, Part I, which is described as "General," includes the following: Government control of packaging, package testing, British Standards, importance of trade marks, shipping requirements, packaging and despatch by road, rail and air, packaging for the tropics, insurance of goods, dispatch and packaging layout, etc. Remaining sections include: packing and display in industry, design, display methods and materials, metal containers, crates and containers in wood, bags and envelopes, cartons and boxes, liners, surface decoration, shockproof packing, adhesives, plastics in packaging and display, and raw materials.

The Microscopic Examination of Plastic Materials

VII.—Mouldings

By J. H. WREDDEN, F.R.M.S.
(Chief Chemist, Igranic Electric Co., Ltd.)

IN recent articles fillers have been dealt with as regards the part they play in a finished moulding. Subjecting them to scrutiny under the microscope, we have seen that the whole question of the part played by them in the moulding was rather more complex than was hitherto suggested. At the outset it became clear that the shape of the filler particle had a pronounced influence on the ultimate strength of the moulding, of which it formed an integral part. On the evidence shown, it was concluded that particles of certain shapes would perform better or worse, according to whether this shape conformed to an ideal which we were enabled to develop as a result of the examination.

A further result of the effects of this work are seen in the dimensional relationships which have been suggested, as regards the filler particle. It was shown how a particular flour could be analysed dimensionally by examination under the microscope, when it became possible to determine the size of the particles and so segregate them into one or more groups, based on an average size for each group. According to the relative variations in size existent in the filler at the same time, it is also possible to obtain an estimate as to the quantity of extraneous dust and other matter present. By these means it is possible to obtain a certain amount of fairly definite information regarding the behaviour of the filler, by interpreting its average morphological characteristics in terms of length-to-breadth ratio and the variability index, from which figures it is possible to obtain an idea of the shape and size of the average particle. When further examined —in the light of knowledge conveyed by the number of fractions present and their individual L.B. ratio and variability indices—fillers of different quality and type may be compared with a reasonable degree of accuracy, so far as their general utility for this purpose is concerned.

Apart from being able to assess the morphological characteristics of a filler, microscopical examination is also a means by which information is forthcoming upon the nature of filling material. Forearmed with a knowledge of the structure of plants and wood, it is possible to know, with some degree of certainty, whether a particular material is composed entirely of particles derived from wood or whether it is a mixture of wood and straw, or even whether it contains leaf tissue or some other plant tissue, which may or may not be desirable as a constituent. One may even go further, in being able to determine the type of wood in a pure wood filler, i.e., whether it is coniferous or deciduous, and in some cases even to state the actual species of wood, i.e., whether it be pine or spruce, or oak or beech. In much the same way, other natural materials may be identified, and knowing the structural differences between the various vegetable fibres, it becomes possible to identify them with reasonable certainty in any particular filler; the same remarks apply in the case of nut shells.

As a result of this it has been shown that considerable improvement in a filler could be produced by endeavouring to obtain a variability ratio as low as possible, unity being the ideal. It was sug-

gested that this could be achieved by a study of the methods used for reducing the raw material, in particular the grinding operations. It appears probable that greater improvement may be effected by careful screening of the product of the grinding machines; in connection with which the importance of conveying the maximum of information in the designation of mesh for any particular flour is again emphasized, as it seems reasonable to suggest that it is preferable to describe a particular flour as being 100 per cent. through one mesh and 100 per cent. stopped by another (smaller) mesh, the two meshes being as close as possible.

Other information of not inconsiderable value has also been obtained by these means; for example, that furnished by the examination of the coconut-shell particle, which led to the formation of certain conclusions regarding the suspected existence of an outer layer of reactive lignin on the surface of the particle. It was suggested this ligneous layer could take part in the resin reaction, thus resulting in the production of greater adhesion between the surface of the filler particle and the resin matrix, tending in some degree to negate the adverse effects produced in the finished moulding by the somewhat poor and rather spherical shape of the particle. When the coconut-shell flour was tried as a filler these conclusions received a remarkable degree of support in that the strengths were higher than those expected; indeed, whereas it was expected that the strengths would approach fairly close to those for standard wood-flour fillers, in actual fact they were in excess of these. The case was made more remarkable by the fact that moulding powder made with coconut-shell flour contained 30 per cent. resin, while the powder made with wood flour contained 50 per cent. resin.

As a result of the information obtained by subjecting filling materials to microscopic examination, it is possible to establish a system of analysis whereby information as to the physical properties and, in some degree, the nature of the raw material from which the filler is produced, may be obtained. This will possibly enable us to formulate a given moulding powder and forecast its final characteristics to a degree somewhat greater than hitherto possible.

Suggested lines on which such a system may be developed are given in Tables 1 and 2. The data contained therein cover a fairly wide field, but it is not suggested that the information given is as comprehensive as it could be. However, it is to be regarded as a broad outline on which the worker in this field may build his own system for the examination of these substances. This is due to the fact that images as seen in the microscope must be interpreted in terms of the imaginative imagery and power of expression of the observer; for example, with three observers examining the same field it is likely that there will be three differing interpretations. Admittedly, the difference in all probability would be one of degree, involving the finer details, but it should not be forgotten that, in this case, as in very many others, the fine detail is the important element in the result. Therefore it cannot be too strongly emphasized that, whereas a basic system of analysis may be quite easily laid down, the details of such a system can be filled in only by the individual. The extent of this will be dependent on experience and training. The analysis may be on lines indicated below:—

Morphological Character

(1) Fractions Present.—The number of fractions present may be obtained by measurement under the microscope or by planimetric measurement carried out on photomicrographs. The flour may be divided into one or more groups, based on an average L.B. ratio for each group. The range covered by the average of this figure for each group is fixed at any convenient value, but should not exceed 2 to 1 between the largest and the smallest particle in any one group.

an idea of the shape and size of the possible, unity being the ideal. It was sug-

Fig. 266.—Section of moulding filled with wood flour of mixed particle size. Mag. 85 diameters.

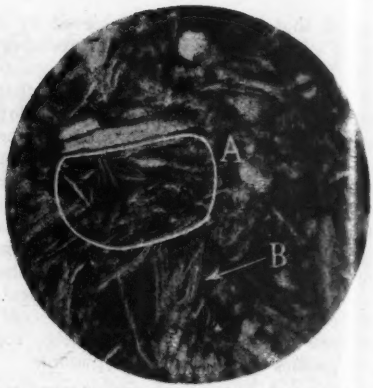


Fig. 267.—Section of moulding filled with mixture of mica and wood flour. Mag. 85 diameters.

(2) EXTRANEOUS MATTER.—If there is sufficient extraneous matter, consisting of large, measurable particles, this may be expressed as an extra fraction and its amount estimated by planimetric analysis of the field or a photomicrograph. In the majority of cases, however, the extraneous matter is present in the form of fine dust, and this can be estimated only by examing the field with a squared graticule, which has previously been calibrated, in the ocular of the microscope and estimating the area occupied by the dust. The result may be expressed as an estimated percentage of the whole.

(3) AVERAGE LENGTH-TO-BREADTH RATIO OF EACH FRACTION.—This figure is expressed as the average L.B. ratio for the group or fraction concerned and is obtained by striking the average of the L.B. ratios of at least 10 particles in each group.

(4) VARIABILITY INDEX OF EACH FRACTION.—This is the ratio existing between the areas (i.e., length times breadth) of the largest and smallest particles in the fraction under consideration; the ideal value for the V.I. of any fraction or whole flour is, of course, unity.

(5) AVERAGE LENGTH-TO-BREADTH RATIO FOR WHOLE FLOUR.—This figure is the average of the L.B. ratios of the fractions present in the flour.

(6) VARIABILITY INDEX FOR WHOLE FLOUR.—This is the ratio existing between the area of the largest particle in the group consisting of the largest units and the area of the smallest particle in the group containing the smallest units. It should be borne in mind that the fractions concerned in the L.B. ratio and V.I. determinations do not include any which are present as extraneous matter. These are expressed as an estimated percentage of the whole, together with the fine dust.

Particle Identification

(1) WOOD FLOURS.[1]—Much may be learned of the history and origin of the wood in wood flours by examining them under the microscope, particularly if the investigator is forearmed with the knowledge of the structure of wood and its development. Thus, in endeavouring to identify the particular type or types of wood constituting a sample of wood flour the two main divisions into which woods in general are divided should be borne in mind; these are the coniferous and deciduous woods.

The differences in structural characteristics of these two divisions are so marked as to constitute a reliable guide to their identification.

information as to the physical proper- smallest particle in any one group.

Fig. 268.—Section of moulding filled with mixture of wood and mica Flour. Mag. 160 diameters.

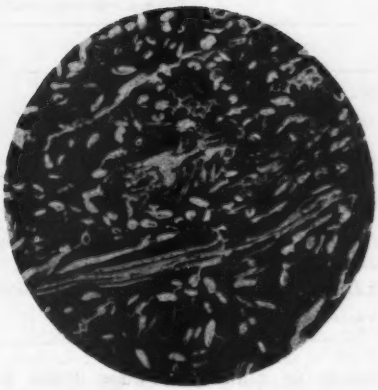


Fig. 269.—Section of cotton-filled moulding. Mag. 140 diameters.

The conifers possess tracheids only in their xylem tissue. The tracheids are relatively short and thin-walled. They are furnished with pits in the walls, which are distinctive in character; i.e., the bordered and semi-bordered pits and the rectangular pits, to be found in Pinus silvestris. One feature, which seems to be characteristic of this latter species, is the presence of a small, semi-bordered pit at the point of intersection of medullary rays.

In the deciduous woods, however, the xylem tissue contains numerous vessels of considerable length and, in many cases, of large diameter. In addition, pitting may take various forms; for example, this may be sclariform or reticulate, or may consist of a spiral or even closely spaced minute "dots." These characteristics are sufficient for the investigator to tell at a glance whether the wood is coniferous or deciduous, or a mixture of both.

The identification of actual species is not so simple. It requires a somewhat extensive knowledge of wood histology. The chief information required for industrial purposes, however, is whether the wood flour is composed of softwood or hardwood or is a mixture.

(2) Fibrous Flours.[2]—The identification of the species of fibre used in fibrous flours is difficult and lengthy, and does not lend itself readily to adoption as an industrial method, where quick results are required. This is due mainly to the small differences in structure between the majority of commercial fibres (jute, hemp, flax, ramie, etc.), which are relatively easy to identify when one has the whole fibre to work with. When, however, these fibres are ground up to produce a flour the difficulty of identifying them as separate species makes it an impracticable proposition for industrial purposes, although there are certain characteristics, such as the twist in cotton, the uneven lumen in jute, the closely spaced cross-markings in hemp, etc., which help in establishing information as to the nature of the material present.

Fibres may be classified into groups in a similar manner to that employed for wood, according to whether they are seed hairs, leaf fibres, bast fibres, etc. The identification of straw in a flour is made relatively simple by the presence of parenchymatous cells and those originating in the epithelial tissue and possessing the serrated edges so typical of this type of cell. In this case, the average size of these cells is quite a good guide to the species of straw. However, it should be

Table I.—Dimensional Analyses of Wood Flours.

Characteristics		No. 1	No. 2	No. 3
No. of fractions present		2	3	4
Dust present		Yes	Yes	Yes
L.B. Ratio of fractions	1	7 : 1	3.4 : 1	9.8 : 1
	2	1.6 : 1	17 : 1	2 5 : 1
	3	—	25 : 1	22.5 : 1
	4	—	—	13.5 : 1
V.I. of fractions	1	1.7	1.5	1.5
	2	1.3	3.5	1.5
	3	—	2.0	3.5
	4	—	—	3.2
L.B. Ratio for whole flour		4.25 : 1	15 : 1	12 : 1
V.I. for whole flour		5.2	7.0	66

borne in mind that these types of extraneous tissue are frequently found in fibres produced from some grasses, for example, Esparto.

(3) SHELL FLOURS.—The identification of shell flours is not as straightforward as it is for the straws. In the case of coconut shell, the particle is so characteristic as to constitute its own means of identification. However, this is not the case with walnut and apricot; the majority of shells of this type are very similar in structure, as a result of which they are difficult to identify as individual species; yet as a general rule shell flours may be readily distinguished from the products from other natural materials inasmuch as the cells are generally isodiametric and may exist as single units or in groups of three or more. The notable exception to this rule appears in the coconut shell, the cells of which vary in size and shape to a much greater extent.

It will be seen that the basic system has been divided into two parts. The first deals with methods which might be employed in order to obtain information relating to the dimensional properties. Thus, micrometry, both directly and indirectly—by means of planimetric measurements on photomicrographs—has been suggested as a reasonably reliable means of obtaining such figures as the L.B. ratio and variability index. Additionally, the flour may be initially split up into groups or fractions, depending on the dimensional characteristics of the average particle for each group, after which further measurement is capable of producing the information shown.

Having obtained this information, it would, perhaps, be as well to examine it and see how it may best be used. In Table 1 the results of the dimensional analyses of three grades of wood flour are tabulated, to furnish a comparison between them. From these results it will be seen that the first is capable of being divided into two fractions, the second into three fractions and the third into four. As they were all originally quoted as being 80 mesh, it will be seen that flour No. 1 is obviously screened to closer tolerances than flour No. 3; in fact, the number of fractions present is a good indication of the degree and tolerances to which the material has been screened. It will be noticed that dust is present in each fraction.

On examining the L.B. ratios of the individual fractions we see that, for the first sample, the first fraction has an average particle ratio of 7 : 1. This, of course, means that the average particle in this fraction is seven times as long as it is broad. If this is compared with the ratio for the next fraction, we find that the average particle here is only 1.6 times as long as it is broad. In the first case the particle is long and thin as compared to that in the second, which is almost cubical; bearing this in mind, it is

species of straw. However, it should be

Table 2.—Contents Analyses of Wood Flours.

		No. 1.	No. 2.	No. 3.
Percentage of fractions	1	3	50	40
	2	92	35	30
	3	—	12	15
	4	—	—	15
Percentage of dust	—	5	3	trace

possible to form an opinion as to the texture of a flour containing two such fractions.

In view of the fact that in tabulating these L.B. ratios they are arranged with the fraction containing the largest particles first, it will be seen that the first flour may be inferred as being relatively coarse, but this does not hold for all cases as the ratios for the second flour will be seen to be in the reverse order and those for the third are mixed, so that, without the actual average size, one cannot say whether any particular fraction contains particles larger or smaller than any other.

Thus, the L.B. ratio should, in itself, be regarded merely as an indication of the shape of the particle, and in this way we may quote the L.B. ratio for the whole flour as being an estimate of the mean effective shape of the particle for the flour concerned. From this information it is possible to obtain a rough idea as to whether any particular flour consists of particles which are, in general, "long and thin" or "short and fat."

On the other hand, if an idea of the quantity of each fraction present in a flour can be obtained, then further information is revealed. Such an analysis, based on measurement of the same three flours, is shown in Table 2, from which we see that the fraction with the 7 : 1 L.B. ratio in the first sample exists only to the extent of about 3 per cent. in the whole, from which it may immediately be inferred that the influence of this fraction in the functionality of the whole flour is small when compared to that exerted by the other, and that the flour might be considered as consisting of particles which are mainly relatively "short and fat." Further information on this point may be obtained by tabulation of average particle sizes.

However, the tabulation of sizes involves a considerable amount of work in measuring numbers of particles, and for the purpose of industrial control evaluations it is liable to take up so much time as to become uneconomical. The results of ignoring this may be offset to an appreciable degree by the variability index (V.I.), which, being based on the largest area the particle presents to view, gives an indication of the difference in particle size to be expected. Thus, in the case of the first flour, the V.I. for the fractions indicate that these in themselves are not subject to any great variation in particle size. This is to be expected as the fractions are established on fairly close tolerances, but when we examine

Fig. 270.—Section of moulding filled with masticated fabric, but containing a little wood flour. Mag. 160 diameters.

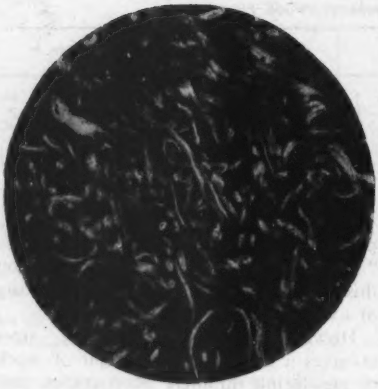


Fig. 271.—Section of pure cotton-filled moulding. Mag. 85 diameters.

Fig. 272.—Section of moulding filled with masticated fibre. Mag. 85 diameters.

the V.I. for the whole flour we find the figure 5.2, signifying that the largest particle is bigger than the smallest by this amount. From this it may be inferred that one of the fractions is generally bigger with regard to particle size.

The effect of indifferent screening is well shown in the third flour, which possesses four fractions. The V.I. of these are good, when considered individually, but their effect on the whole is well shown by the big variability index of 66. This means that the flour is capable of being split up, so that four separate materials of different mesh size and good V.I. may be produced.

The foregoing suggestions for a system of analysis deals only with the filler before its incorporation into a moulding powder. When it comes to the question of the finished moulding we encounter somewhat different circumstances, for the filler is now an integral component of a whole and, therefore, in attempting to examine the finished article it is desirable to bear this in mind. One must remember that besides the filler there is an appreciable amount of resin, together with various other substances; not the least influential are the dyes or pigments present in the majority of cases.

Further to this, it must not be forgotten that the filler would have been subjected to considerable pressure and therefore must suffer morphological modification to an appreciable extent. Thus the question of subjecting mouldings to microscopical examination resolves itself, in the main, to the problem of adopting suitable methods whereby the material may be put into a state allowing it to become visible under the microscope. One method of doing this is to prepare a section thin enough to be transparent, so that it can be examined in transmitted light.[3]

By way of introducing this technique, it is proposed to examine very briefly the sections of a few typical materials at various magnifications. A standard wood-flour filled material (Fig. 266), at a magnification of 85 diameters, shows that the filler is very mixed, in so far as the particle size is concerned. The general structure and lack of orientation of the filler is well illustrated, and it is easy to develop interesting lines of thought regarding the stress distribution in a structure such as this.

Similar light is thrown on the structure in the case of a mixed filler, such as mica and wood flour (Fig. 267), but this case is more difficult to interpret. The majority of the minute mica flakes are

Fig. 273.—Section of moulding filled with mica flour. Mag. 85 diameters.

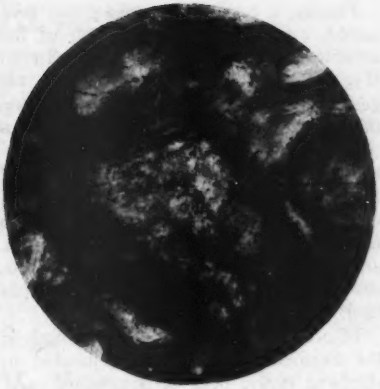


Fig. 274.—Transverse section of the U.F paper-filled moulding. Mag. 400 diameters.

seen " edge-on," as shown by the group at A, while a typical wood particle is seen at B. Even a cursory examination has to be carried out carefully if a correct interpretation is to be obtained. For this reason it is advisable to make sections in different directions through the moulding and examine the whole of each of them.

The need for careful discrimination is clearly illustrated in Fig. 268, showing another portion of the same mica and wood-filled section at a magnification of 160 diameters. Here two mica flakes are seen at A, viewed from the broad face, and once again a wood particle is clearly visible at B, while contrary to expectations the group of particles at C is not composed of wood flour, but is actually a group of mica flakes viewed edge-on. However, by means of these thin sections it is apparent that a cursory examination enables the investigator to tell quickly, and with reasonably greater certainty than hitherto, the nature of the filler in any given moulding. More particularly is this the case when it comes to differentiating between organic and inorganic fillers, for these latter, apart from being detectable by ordinary chemical tests, are also easily distinguishable if polarized light is used in viewing these thin sections.

The utility of this method of investigating the finished moulding may be illustrated by a practical example. A case which was investigated by the author concerned certain mouldings which called for a pure-cotton filling, and which kept failing in practice when this should not have occurred. In spite of the repeated assurances by the manufacturer that the filling was pure-cotton linters, the mouldings continued to fail, and it was finally decided to prepare a section for examination under the microscope and so check the filler. Fig. 269 shows a portion of one of the sections at a magnification of 160 diameters. Here it is abundantly clear that although the majority of the filler is certainly cotton linters, the amount of wood actually present is too large to be ignored; indeed, quite large enough to account for the premature failure of the moulding.

A planimetric analysis of the whole section revealed that wood flour existed to some 20 per cent. of the total filler. On taking the matter up with those concerned, further mouldings were produced which were stated to be filled with pure cotton only. In one section, however, wood flour was still observed to be present to the extent of about 5-10 per cent. (Fig. 270).

Finally, a pure-cotton filling was produced, resulting in the abolition of the trouble. A section of this material (Fig. 271), at 85 diameters, illustrates the general appearance of a pure-cotton filling and, at the same time, demonstrates the usefulness of microscopic examination in cases where minute amounts of undesirable substances may be rapidly detected. It will be seen that the cotton fibres exhibit their characteristic shapes, and also that they are in all directions, showing little, if any, directional orientation.

In order to achieve greater strength in the finished moulding, a masticated or chopped fabric filler is sometimes used. The section of a moulding containing such a filler (Fig. 272), at 85 diameters, shows that a much greater degree of orientation is obtained, with consequent increase in strength. It should be noted that fabrics woven from different fibres, both natural and synthetic, may be used for this purpose and, therefore, this method of examination can be employed as a ready means of identification of the fibre in many cases.

Contrasting with the fabric filler, Fig. 273 shows the section of a pure-mica-filled moulding; the appearance is typical and unmistakable, particularly if polarized light be used.

By way of illustrating the capabilities of this method, Fig. 274 shows a section of paper-filled U.F. moulding and indicates how the pigment granules (in this case zinc oxide) may be clearly seen, together with certain structural details of the paper, such as odd fibres in cross-sections, etc., made visible at higher magnifications.

(To be continued.)

REFERENCES

(1) *Wise*, "*Wood Chemistry*" (*Reinhold*). (2) *Matheus*, "*Textile Fibres*," *5th Edn.* (*Wiley*). (3) *Wredden*, "*The Microscope*," p. 262 (*Churchill*).

Spraying Synthetic Resin Adhesives

THE need for a reliable method of spraying urea-formaldehyde adhesives has long been felt in the building, joinery and aircraft industries, but the difficulty of spraying a mixture which increases in viscosity, and which will finally set to a rock-hard solid, has hitherto proved almost insuperable.

A device recently introduced successfully overcomes this difficulty. It consists in using a spray gun, the nozzle of which carries two jets of suitable relative size. The larger jet is connected to the supply of unmixed urea-formaldehyde syrup, and the smaller jet to the hardener solution. A metering device, designed to allow for the differences in viscosity of the two fluids as well as for quantities delivered, is embodied in the system. In this way about ten times as much syrup as hardener occurs in the spray, and mixing is effected at this point. Thus, since the syrup does not begin to set until it has left the gun, no trouble from setting arises, and the maximum pot life of the mixture is available to the user as open assembly time.

The same principle can be applied to resins which require a catalysing solution to be added before they are ready for application: contact resins come into this class.

It is considered that this device will greatly extend the use of synthetic adhesives and lessen considerably the limitations imposed by pot life. It is also possible that, since working in this way reduces to a minimum the actual handling of the adhesives, the device will tend to lessen the incidence of dermatitis.

The building, joinery and aircraft industries will be interested in this device, as also will users of contact resins who mix these materials with solid fillers for making blocks.

Plastics Education in Denmark

At the end of 1947 the Institute of Technology in Copenhagen started the first open education on plastics to be given in Scandinavia. Mr. Niels Jacobsen, M.Sc., in a course of four lectures, gave a survey of materials and processes, each lecture being followed by films and some discussion. The course was suggested largely as an experiment to find out if any real interest in the technology of plastics existed. Actually it proved to be a success, with more than 170 people attending.

PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office, with the permission of the Controller of H.M. Stationery Office. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

B.P. 593,995. Application date: 22.6.45. Accepted: 30.10.47.

Improvements in or relating to Dice. A. E. Davey. To: Injection Moulders, Ltd.

B.P. 594,001. Application date: 29.6.45. Convention date (U.S.A.): 30.6.44. Accepted: 30.10.47.

Improvements in or relating to Vinyl Resins. To: E. J. du Pont de Nemours and Co.

Insolubilization of an organic solvent soluble preformed polyvinyl acetal resin (polyvinyl butyral) by blending it with 5-10 per cent. of benzoyl peroxide and heating the blend at temperatures between 100-200 degrees C.

B.P. 594,008. Application date: 8.1.45. Accepted: 31.10.47.

Manufacture of Polymerizable Compounds and of Polymers therefrom. J. St. L. Philpot.

Refers to the manufacture of mercaptoketones (mono- and dimercaptoacetone) from the respective chloroacetones by reacting them with sodiumhydrosulphide.

B.P. 594,017. Application date: 4.4.45. Convention date (U.S.A.): 13.11.44. Accepted: 31.10.47.

Water Resistant Coated Film. To: Wingfoot Corp.

Improving the resistance to water vapour transmission of polyvinyl chloride films by passing them through a solution of a copolymer of vinylidene chloride and vinyl chloride in a liquid in which these films are insoluble but which causes them to swell, and subsequent drying after removal from the bath.

B.P. 594,075. Application date: 3.7.44. Convention date (U.S.A.): 1.7.43. Accepted: 3.11.47.

Coated Flexible Sheet Material. To: Imperial Chemical Industries, Ltd.

Refers to the manufacture of flexible sheets coated with N alkaxymethyl polyamides.

B.P. 594,093. Application date: 26.6.45. Accepted: 3.11.47.

Improvements in or relating to the Production of Compositions containing Derivatives of Balata Resin or Gutta-Percha Resin or similar Resins and to Products covered with a protective coating thereof. F. A. Jones and D. F. Twiss. To: Dunlop Rubber Co., Ltd.

B.P. 594,101. Application date: 26.6.45. Accepted: 3.11.47.

Improvements in or relating to the Production of Resinous Condensation Products. A. A. Drummond and J. W. Dorling. To: Imperial Chemical Industries, Ltd.

Manufacture of resinous condensation products by reacting under heat urea, succinamide and formaldehyde or a formaldehyde liberating substance in the presence of a monohydric alcohol (normal butylalcohol).

B.P. 594,126. Application date: 30.6.44. Accepted: 4.11.47.

Improvements in Coated or compound Sheet Material comprising a fibrous layer and a Waterproof Barrier Layer. To: H. H. Robertson Co.

B.P. 594,154. Application date: 9.4.45. Accepted: 4.11.47.

Stabilizing Organo-Siloxanes. To: Corning Glass Works.

B.P. 594,217. Application date: 29.6.45. Accepted: 5.11.47.

Production of Coloured Filaments, Films and other Articles from Organic Filament-forming Materials. J. G. Gillan, J. L. Moillier and W. Todd. To: Imperial Chemical Industries, Ltd.

B.P. 594,222. Application date: 29.6.45. Accepted: 5.11.47.

Improvements in the Manufacture of Organic Fibrous Materials of Improved Fire Resistance. A. J. Wesson and H. C. Olpin. To: British Celanese, Ltd.

Fireproofing of cellulose-ether and -ester fibres, also of regenerated cellulose by padding with ethylene diamine dehydrobromide and subsequent drying.

B.P. 594,249. Application date: 1.5.45. Accepted 6.11.47.

New and Improved Process for the Production of Copolymers of Tetrafluoræthylene. To: Imperial Chemical Industries, Ltd.

Production of copolymers of tetrafluoræthylene and olefinic hydrocarbons, having good solubility in organic solvents and improved workability, by polymerizing under heat and pressure a mixture containing at least 50 per cent. by weight of tetrafluoræthylene and the olefinic hydrocarbon

(isobutylene) in the presence of a non-polymerizable liquid and a peroxide catalyst.

B.P. 594,330. Application date: 23.4.45. Convention date (U.S.A.): 22.4.44. Accepted: 7.11.47.

Coating compositions. To: E. I. Du Pont de Nemours and Co.

Vinyl resin coating composition prepared by grinding one part of a vinyl resin containing polyvinyl chloride with two to four parts by weight of a volatile liquid which is capable of swelling the resin at room temperature, thus preventing settling. Such coatings may be applied to metals, fabric, paper, glass, plastics, etc.

B.P. 594,332. Application date: 27.4.45. Accepted: 7.11.47.

Improvements in or relating to the Production of Coated Sheet or Film. To: British Celanese, Ltd.

B.P. 594,372. Application date: 8.6.45. Convention date (France): 8.8.41. Accepted: 10.11.47.

Improved Process for the Manufacture of Plastic Products by Means of Synthetic Resins. To: Salpa Francaise.

Refers to polyvynil resin compositions plasticized with anthracene.

B.P. 594,378. Application date: 25.6.45 and 18.1.46. Accepted: 10.11.47.

Improvements relating to Plasticizers for Thermoplastic Compositions. A. J. Daly and W. G. Lowe. To: British Celanese, Ltd.

Plasticization of cellulose derivative with ethylene or diethylene glycol acetate benzoate.

B.P. 594,398. Application date: 9.5.44. Accepted: 11.11.47.

Plastic Composition. J. D. Ryan.

Thermoplastic dental composition comprising a polyvinyl acetal, stearic acid and a plasticizer (oleic acid or an alkyl phthalate).

B.P. 594,436. Application date: 14.6.45. Accepted: 11.11.47.

Method of Finishing Plastic Filaments in Brushes. To: Lever Brothers and Unilever, Ltd.

Finishing and shaping of thermoplastic bristles by applying heat to the free ends of the bristles in order to melt them, allowing the molten ends to solidify and pulling away the melted portions when solidified.

B.P. 594,462. Application date: 14.7.44. Convention date (U.S.A.): 15.9.43. Accepted: 12.11.47.

Improvements in Vinyl Resin Coating Compositions. G. M. Powell. To: Carbide and Carbon Chemicals Corp. Amendment to B.P. 561,800.

Lacquer coating of improved solvent resistance, consisting of a vinylchloride-acetate copolymer, a plasticiser and finely divided lead, lead salts or oxides. Surfaces so coated are baked at a temperature between 325 degress F. and 800 degrees F.

B.P. 594,475. Application date: 15.2.45. Convention date (U.S.A.): 9.9.44. Accepted: 12.11.47.

Polymeric Detergents. To: Röhm and Haas Co.

B.P. 594,476. Application date: 15.2.45. Convention date (U.S.A.): 9.9.44. Accepted: 12.11.47.

Polymeric Detergents. To: Röhm and Haas Co.

B.P. 594,477. Application date: 15.2.45. Convention date (U.S.A.): 9.9.44. Accepted: 12.11.47.

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B.P. 594,478. Application date: 15.2.45. Convention date (U.S.A.): 9.9.44. Accepted: 12.11.47.

Polymeric Detergents. To: Röhm and Haas Co.

B.P. 594,479. Application date: 15.2.45. Convention date (U.S.A.): 9.9.44. Accepted: 12.11.47.

Polymeric Detergents. To: Röhm and Haas Co.

B.P. 594,481. Application date: 13.3.45. Convention date (U.S.A.): 14.3.44. Accepted: 12.11.47.

Improvements in and relating to Di-Methyl Silicon Elastomers. To: The British Thomson-Houston Co.

B.P. 594,506. Application date: 3.8.45. Convention date (U.S.A.): 11.8.44. Accepted: 12.11.47.

Improvements in and relating to Di-Methyl Silicon Elastomers. To: The British Thomson-Houston Co.

B.P. 594,508. Application date: 6.11.45. Convention date (U.S.A.): 6.11.45. Accepted: 12.11.47.

Improvements in and relating to Methods of Processing Soluble Di-Methyl Silicone Gums. To: The British Thomson-Houston Co.

B.P. 594,579. Application date: 1.[illegible].44. Accepted: 14.11.47.

Improvements in or relating to Mouldable Compositions. N. W. Knewstubb and J. H. Bennitt. To: Bakelite, Ltd.

Mouldable composition comprising randomly disposed filaments, cord or cuttings of nylon, which have been coated or impregnated with a phenal-aldehyde resin

at a temperature low enough to avoid fusion of the nylon or dissolution of the nylon in the binder.

B.P. 594,610. Application date: 9.11.45. Accepted: 14.11.47.

Improvements in and in the Manufacture of Articles of a Decorative Character. S. R. Warner and J. H. Warner.

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B.P. 594,796. Application date: 4.4.45. Convention date (France): 7.2.44. Accepted: 19.11.47.

Method for obtaining a product that may be used for causing rubber to adhere to another material. To: Société Auxiliare de l'Institut Francais du Caoutchouc.

Refers to the preparation of a cement which will stick rubber to metals and plastics by dissolving rubber in a solvent, adding acrylo-nitrile and benzoyl peroxide, heating the solution until it gels, drying the jelly and pulverizing the residue, adding phenyl-beta-naphthylamine and kneading the mixture until it is soluble in solvents for rubber.

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Moulding machine comprising a plurality of sets of fluid-pressure-operated die members rotatable in stages through a moulding cycle during which the members are successively closed, compressed and opened, and the moulded articles ejected.

B.P. 594,891. Application date: 29.12.44. Convention date (U.S.A.): 2.12.43. Accepted: 21.11.47.

Improvements relating to Ethylene Polymers. To: Western Electric Co. Inc.

Stabilization of solid ethylene polymers by adding an antioxidant consisting of phenyl alpha naphthylamine and diphenyl para-phenylene diamine.

B.P. 594,985. Application date: 9.4.45. Convention date (U.S.A.): 12.4.44. Accepted: 24.11.47.

Improvements in or relating to the Securing of Shoe Uppers to Insoles or in or relating to Machines suitable for use therefor. M. F. Ashley and T. J. Ryan. To: The British United Shoe Machinery Co., Ltd.

FLEXIBLE MOULDS FROM VINYL COMPOUNDS

(*Continued from page* 117).

either by the water in the mix or by the heat generated in setting. Any particles of plaster left in the mould are washed out under the tap. By inserting cores of Vinamold, hollow articles can be made.

The commercially available phenol-formaldehyde-type cold-setting resins do not affect the Vinamold and can be cured in such moulds either by cold setting or by curing at an elevated temperature. The prepared casting solution is filled into the mould which again requires no pretreatment. When filling, care is necessary to avoid trapping of air bubbles. Slanting undercuts and relatively large filling holes assist in this.

Preparation of the casting solution and a filling under vacuum, where practical, are of assistance in achieving faultless products. A quick-curing cycle is obtained by placing the filled mould in an oven at a temperature of 70-80 degrees C. Vinamolds HMC.21 and HMC.774 will withstand prolonged heating at 70-80 degrees C. (158-176 degrees F.) without distortion. At this temperature, however, the tensile strength and elasticity are lower and the mould is more easily damaged by too early a withdrawal of the casting.

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Table I.—Dimensional Analyses of Wood Flours.

Characteristics		No. 1	No. 2	No. 3
No. of fractions present		2	3	4
Dust present		Yes	Yes	Yes
L.B. Ratio of fractions	1	7 : 1	3.4 : 1	9.8 : 1
	2	1.6 : 1	17 : 1	3.5 : 1
	3	—	25 : 1	22.5 : 1
	4	—	—	13.5 : 1
V.I. of fractions	1	1.7	1.5	1.5
	2	1.3	3.3	1.5
	3	—	2.0	3.5
	4	—	—	3.2
L.B. Ratio for whole flour		4.25 : 1	15 : 1	12 : 1
V.I. for whole flour		3.2	7.0	66

borne in mind that these types of extraneous tissue are frequently found in fibres produced from some grasses, for example, Esparto.

(3) SHELL FLOURS.—The identification of shell flours is not as straightforward as it is for the straws. In the case of coconut shell, the particle is so characteristic as to constitute its own means of identification. However, this is not the case with walnut and apricot; the majority of shells of this type are very similar in structure, as a result of which they are difficult to identify as individual species; yet as a general rule shell flours may be readily distinguished from the products from other natural materials inasmuch as the cells are generally isodiametric and may exist as single units or in groups of three or more. The notable exception to this rule appears in the coconut shell, the cells of which vary in size and shape to a much greater extent.

It will be seen that the basic system has been divided into two parts. The first deals with methods which might be employed in order to obtain information relating to the dimensional properties. Thus, micrometry, both directly and indirectly—by means of planimetric measurements on photomicrographs—has been suggested as a reasonably reliable means of obtaining such figures as the L.B. ratio and variability index. Additionally, the flour may be initially split up into groups or fractions, depending on the dimensional characteristics of the average particle for each group, after which further measurement is capable of producing the information shown.

Having obtained this information, it would, perhaps, be as well to examine it and see how it may best be used. In Table 1 the results of the dimensional analyses of three grades of wood flour are tabulated, to furnish a comparison between them. From these results it will be seen that the first is capable of being divided into two fractions, the second into three fractions and the third into four. As they were all originally quoted as being 80 mesh, it will be seen that flour No. 1 is obviously screened to closer tolerances than flour No. 3; in fact, the number of fractions present is a good indication of the degree and tolerances to which the material has been screened. It will be noticed that dust is present in each fraction.

On examining the L.B. ratios of the individual fractions we see that, for the first sample, the first fraction has an average particle ratio of 7 : 1. This, of course, means that the average particle in this fraction is seven times as long as it is broad. If this is compared with the ratio for the next fraction, we find that the average particle here is only 1.6 times as long as it is broad. In the first case the particle is long and thin as compared to that in the second, which is almost cubical; bearing this in mind, it is

m and i

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Leaves from a Moulder's Notebook

This is the sixteenth in a series of notes by the B.I.P. Development Department on the problems of the moulder and designer. Nos. 1—12 in this series are now available in booklet form and B.I.P. will be pleased to send a copy of this and subsequent notes on request. Comments and enquiries are welcome.

Transfer Moulding—Gate Areas

More often than not the gate of a mould has been blamed for moulding failures which have actually occurred due to the feed channel being too small in cross section and the mistake has been realised only after alterations to the gate have not produced the desired result.

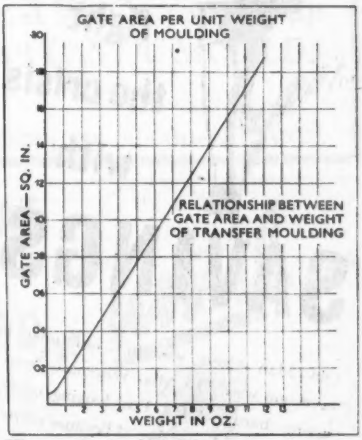
The area (cross section) of a gate in a given transfer mould will depend mainly on the amount of material which is to be fed through it into the mould. Although there are other items that affect the gate area, for instance the length and cross section area of the feed channels, their effect on gate area as a rule is small, except with mouldings of exceptional weight fed by a very short length of feed channel.

Therefore, with the average mould, the area of gate can be planned to suit the weight of material it has to pass ignoring the length and section area of the feed channels. The formula on right has been used with some success on a large number of such moulds; it will be found of great use in providing a starting point in that the gate area resulting from the use of the formula will not be too large and usually adequate in size as regards the average mould. Adjustments, increasing the gate area slightly, may be necessary on certain jobs or with stiff powder, always bearing in mind that the feed channel is usually the feature requiring the alteration.

The formula is :—

$$A = .0156W$$

where A = *area of gate (cross section)*
and W = *weight of charge in ounces*


GATE AREA PER UNIT WEIGHT OF MOULDING
GATE AREA—SQ. IN.
RELATIONSHIP BETWEEN GATE AREA AND WEIGHT OF TRANSFER MOULDING
WEIGHT IN OZ.

The graph plotted from the above equation describes areas of gate section against weights of charge.

For the exception mentioned above, the very heavy moulding having short feeds, for instance a solid section toilet seat, the gate area formula described may produce a gate unnecessarily large. On such mouldings, trial and error still remain safest, starting with comparatively very small gates.

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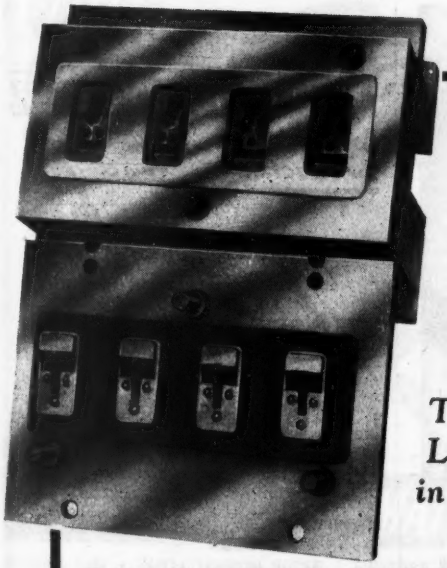

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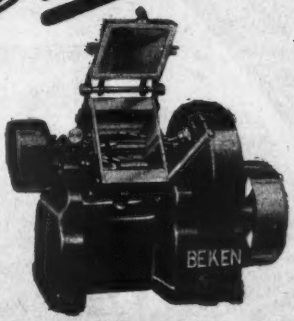

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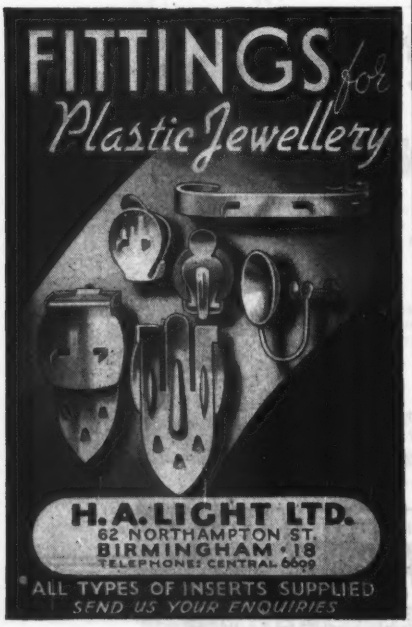

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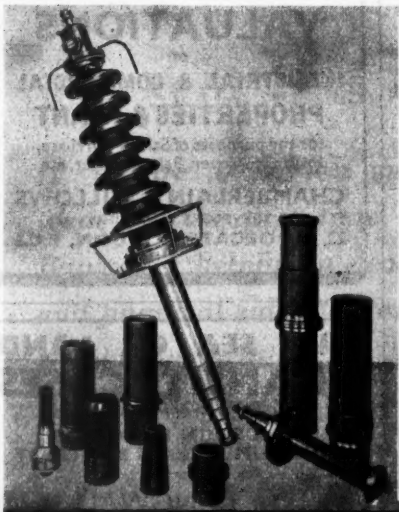

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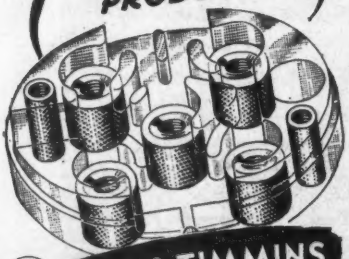

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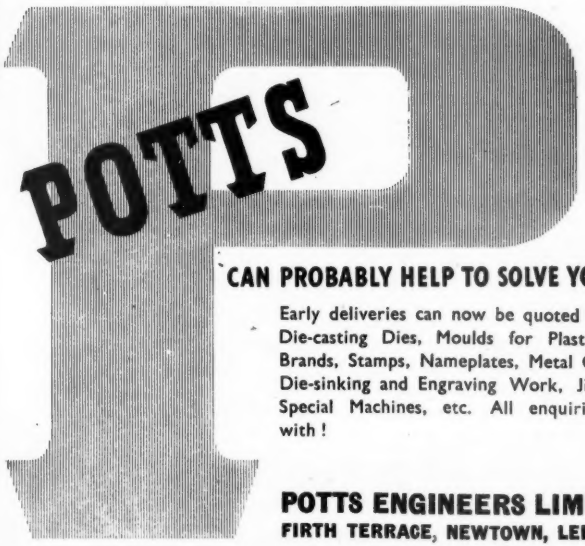

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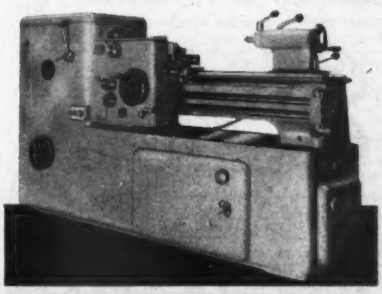

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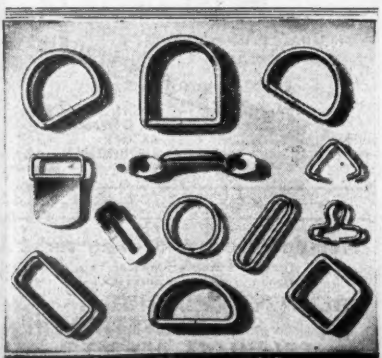

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One Stainless Steel Enclosed PRESSURE and VACUUM MIXER, approximately 1 ft. 10 ins. diameter by 2 ft. 4 ins. deep, about ½ in. thick, bolted top cover with manhole and gianded agitator entry with stainless steel agitator; mild steel outer jacket for 50 lb. per sq. in. steam pressure and crown wheel and pinions fitted to agitator shaft, drive from fast and loose pulleys, mounted in mild steel outer framework, excluding fractionator and condenser.
REED BROTHERS (ENGINEERING), LTD.,
BEVIS MARKS HOUSE,
LONDON, E.C.3.
Phone, Avenue 1677-8.
Grams, "Replant Ald London." 130-3

Five Hydraulic Moulding Presses, prefilling semi-auto platens, 21 ins. by 21 ins., by Hydraulic Engineering and Bradley and Turton.
Shaw Hydraulic Accumulator, 120 tons, cast-iron weight-loaded type, with three-throw pump, motor A.C. 415/3/50. Latest design as new.
Two Shaw Hydraulic Presses, 60 tons, four columns, platens 3 ft. 6 ins. by 4 ft., daylight 6 ft. 6 ins., as new.
"Ingersoll Rand" horiz. compressor, 100 cubic ft. per m.n., motor A.C. 415/3/50.
W. Urquhart, 1023 Garratt Lane, London, S.W.17. 130-4968

For sale, 40-gallon hydraulic accumulator by Tangye, complete with motorized three-throw pumps, weights, H.P. piping and balance accumulator. Low price for early clearance. Apply Brookside Engineers, Ltd., Hydeway, Welwyn Garden City. Welwyn Garden 3666. 131-5110

For sale, two 12-in.-diameter upstroke plastic moulding presses, 24-sq.-in. platten area, 24-in. daylight, 10-in. stroke.
One John Shaw side-ram press, 11-in.-diameter main ram, two 5¼-in. double-acting side rams, 24-sq.-in. platten area, 30-in. daylight, 12-in. stroke.
All in good condition and working on oil.
Apply—Victor H. Iddon, Ltd., Wythenshawe, Manchester. 130-5308

75-ton Thompson Press, new and unused, electrically heated platen with Cambridge thermostatic control, platen size 16-in. sq., 18-in. daylight. Box 2671, care of "Plastics." 130-24

A wide variety of compression and injection moulds for sale, some new. Box 2666, care of "Plastics." 130-21

T.M.A.—EL.9 and a Reavell compressor, Masson Rotary cutter (unused), for sale. Box 2667, care of "Plastics." 130-20

Acid resistant flexible rubber moulds for cast-resin products; our moulds give perfect detail, smooth finish, simplicity of ejection and large output. Decart Products, 3 Widmore Road, Bromley, Kent. 130-x5434

Large heavy-duty trough mixer, complete with direct-coupled reduction gear and motor; may be seen in London area. Offers. Box 2608, care of "Plastics." 130-x5563

New unused solvent recovery plant, not yet installed, capacity 11 gallons/hour, twin absorbers, copper rectification column, all necessary tanks, controls and fittings for automatic operation; site required for absorbers 25 ft. by 10 ft., for rectifiers 15 ft. by 10 ft. Box 2308, care of "Plastics." 130-37

Machinery, Tools and Plant (contd.)

For sale, Pulsometer portable methyl chloride refrigerators; Metro Vickers high vacuum pumping sets; scrap Perspex and cellulose acetate, radar cable, P.V.C. covered, with inside insulation ⅛-in. thick polystyrene. Full particulars, Box 2731, care of "Plastics." 131-5701

Machinery, Tools and Plant, Wanted

Tabletting press required with a minimum depth of fill 2-in., preferably with clutch; state make, model, condition and price. Box 2664, care of "Plastics." 130-23

A 4 impression tail comb mould required immediately by large injection moulders. Must be in first-class condition. Write Box 2845, care of "Plastics." 130-34

PRODUCTION CAPACITY AVAILABLE AND WANTED

Pulverizing and grading of raw materials, Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-369

Wanted, plastic articles of every description for export and British Isles. Representatives active in all parts. Can place large orders for export. Write N. Gerver, Plastic Dept., 2-10 Mare Street, Hackney, London, E.8 131-394

Work wanted, tool room available for all sorts of press tools. Press work, assembling, spraying and all sorts of engineering to your design. Universal Components, Ltd., 19 Sunderland Terrace, W.2. Bay 6776. 131-392

Capacity available any plastic job. Wanted, materials. R. D. Rose, Russell Street Chambers, Bingley, Yorks. 131-x3706

Injection moulding specialists have moulding capacity up to 4 oz. Consultants on all injection moulding problems. Please send inquiries to Box 9761, care of "Plastics." 130-31

Capacity available for plastic work of all descriptions in Perspex, Bakelite, Acetate, P.V.C., etc. Perspex mouldings and manipulation carried out to the highest efficiency in fancy boxes and cartons, all sizes. Box 2847, care of "Plastics." 133-5695

P.V.C. silk screen printing. Table cloths, curtains, nursery patterns, etc. Capacity available for quantity runs. Quality work. Daily deliveries. Guaranteed adhesion and fastness of colour. Davis (Patents), Ltd., 18 Phipp Street, London, E.C.2. 131-5306

We have a large capacity for granulating to any specified mesh your sprues, gates, runners and scrap mouldings. Quotation upon receipt of details regarding quantities, etc. Box 2305, care of "Plastics." 131-5312

Cellulose acetate injection moulding, capacity available up to 1½ oz. Personal supervision for short or long runs. Box 2304, care of "Plastics." 131-5314

Product design or restyling and production capacity in thermo setting materials available. Inquiries invited. Box 2318, care of "Plastics." 131-5315

Bakelite moulding capacity for customers supplying own tools. We can supply powder phenolic, black and brown. Quick delivery. Long runs and export work welcomed. Box 2309, care of "Plastics." 131-5316

We are able to undertake certain short or long runs of highly specialized medical and technical plastic moulded products. Injection, compression or sheet fabrication. Use our services for the preparation of prototypes. All inquiries strictly confidential. Box 7678, care of "Plastics." zzz-422

Injection moulding capacity available on 3-oz. injection moulding machine for short and long runs. Box 9035, care of "Plastics." zzz-438

Reception in Ebonite, Erinoid, etc. Capstan lathe work. Mansell, Temple Street, Rugby. 137-3687

Kingston Plastics, Ltd., Unity Works, Union Street, Kingston-on-Thames, have all the facilities for cleansing, sorting, grinding, kibbling and reprocessing of thermo-plastic materials. Phone, Kingston 8405. 138-4012

Increase sales appeal by colour!
Hand colouring on any plastic smallwares expertly carried out with taste. Long runs only accepted.
Send your samples for quotations to Proda (London), Ltd., 17 Bishop's Bridge Road, London, W.2. 139-4972

Established moulders have injection capacity available. Reply to Box 9305, Williams's Advertisement Offices, Bradford. 130-x5268

Production capacity available for fabricating plastics, adequate stocks Perspex and tool-room facilities available. Inquiries welcomed. Box 2447, care of "Plastics." 131-x5080

Tuning of Perspex and similar plastics undertaken by specialist. The Dorland Electric Co., Ltd., 59 Brompton Road, S.W.3. Phone, Kensington 4201. 130-10

Production Capacity Available and Wanted (contd.)

Moulding and automatic capacity required for electrical accessories, preferably by small and efficient company in London area at present manufacturing switches and lampholders, etc. Materials available. Full details to Box 2677, care of "Plastics." 130-30

"Impossible" moulding propositions invited by pioneer injection moulders with unusually qualified staff and most modern capacity up to 12 oz. Inquiries in strict confidence and without obligation. Box 1241, care of "Plastics." 130-39

Capacity available for the flashing, drilling, barrelling and assembly of mouldings. Dennis, 129 Teesdale Street, London, E.2. 130-x6235

Capacity available on 40-100-ton compression presses. Tools quoted if not available. Box 2732, care of "Plastics." 132-5702

Australian Plastics Industry.
Director of an Australian injection moulding Company now in England invites inquiries from manufacturers wishing to arrange associations with Australia for powder, machines, purchase or hire of moulds and ideas generally. Ring or write for appointment to, C. N. M. Walker, care of Messrs. Ogden, Hibberd, Bull and Langton, Audrey House, Ely Place, London, E.C.1. 132-5700

Inquiries invited for diecasting tools, press tools and for precision milling and jig boring. Hornflowa, Ltd., Maryport, Cumberland. 132-5696

—RAW MATERIAL AVAILABLE AND WANTED—

Tufnol (Carp Brand), 1¼ in. thick, in sheets, large quantity in stock. Reduced prices to clear. Box 2302, care of "Plastics." 130-5311

Clear Perspex, various thicknesses for disposal, including 250 sheets, 36 ins. by 36 ins. by ¾ in. Box 2228, care of "Plastics." 130-x4527

Catalin off-cuts and scrapped material for sale. A. Kahn, 41 Kennington Lane, S.E.11. 132-x5183

For sale, clear Perspex, coloured acetate tube, rod, sheet. E. and H. Grace, Ltd., 125a Hamilton Road, London, S.E.27. 131-x5607

S. R. F. FREED, LTD.,
THE STOCKISTS OF SHEETS, RODS, TUBES, OFF-CUTS AND SCRAP,
OFFER OTHER LINES WHICH CAN BE USED IN COMBINATION WITH PLASTICS,
UTILIZING ANIMAL AND VEGETABLE PRODUCTS.
Such as tortoiseshell, horn, cleaned and prepared cattle bones for industrial purposes, vegetable ivory nuts, porcupine quills, goose and duck feathers, and barrels, etc.
S. R. F. FREED, LTD.,
27b HIGH STREET, SOUTH NORWOOD, S.E.25.
Phones, Livingstone 4042; Sanderstead 2056.
zzz-462

Perspex acrylic sheet. Ensure quick delivery, one of the largest stocks in the country at your service, complete range of colours 1/16-in. to ½-in., recognized stockholders. J. H. Berry, Plastics, Portland Works, Annesley Woodhouse, Notts. 130-4970

LARGE STOCKS HELD OF
ACETATE SHEETING.
TRANSPARENT AND COLOURS.
ALSO PRINTED DESIGNS, LACE, FLORAL, NURSERY AND EXCLUSIVE PATTERNS.
Suitable for Lampshade Trade, etc.
ALLANS,
37 FARRINGDON STREET, LONDON, E.C.4.
Central 5947.
Call if possible 9 to 6. Closed Saturdays.
134-05309

P.V.C. sheeting, thickness .020 in., size 28 ins. by 28 ins., in ripple and water grain finish. Large selection of colours available. Please send for stock list to Box 2850, care of "Plastics." 130-33

An odd parcel of approximately 5 cwt. ground Perspex for disposal. Box 2848, care of "Plastics." 130-35

Acetate cellulose sheeting wanted to purchase for cash, transparent or coloured up to 30 thou. thick, any size or quantity, send samples with details. Allans, 37 Farringdon Street, London, E.C.4. Central 5947. 132-04013

Raw Material Available and Wanted (contd.)

Cellulose acetate scrap urgently required: best prices paid. Write Cuprex, Ltd., Finsbury Pavement House, 120 Moorgate, London, E.C.2. Phone, Metro 9641-5. zzz-206

For sale, P.V.C. scrap. Offers invited. Box 8494, care of "Plastics." zzz-207

We are now able to supply an adhesive suitable for cementing the Perspex which we supply. Inquiries to Cuprex, Ltd., Finsbury Pavement House, 120 Moorgate, London, E.C.2. zzz-208

CUPREX, LTD.,
Stockists of I.C.I. Perspex.
Offer specially:
1/16-in., ⅛-in. and ¼-in. coloured.
Write for stock list and particulars to:—
FINSBURY PAVEMENT HOUSE.
120 MOORGATE.
LONDON, E.C.2. zzz-209

Perspex tubing. We can now supply welded Perspex tubing from ¼ bore upwards. Inquiries invited. Evolite Plastics, Ltd., 325 Latimer Road, W.10. Phone, Lad 1879. 135-5704

For sale, 15 tons P.V.C. black compound (recovered); samples available. Write to Cuprex, Ltd., Finsbury Pavement House, 120 Moorgate, London, E.C.2. zzz-205

Cellulose acetate sheeting, transparent, blue matt/polished, thickness .040 in., size 49 ins. by 21 ins., 52 sheets. Box 2846, care of "Plastics." 130-32

JOHN F. MANN, LTD.,
DIRECT IMPORTERS OF MOULDING POWDERS
Offer
UREA FORMALDEHYDE.
PHENOL FORMALDEHYDE.
POLYSTYRENE, etc., etc.
Prompt and forward delivery.
143 CANNON STREET, LONDON, E.C.4.
Phone, Mansion House 1270. 130-5302

Perspex for sale, new sheets, offcuts, large and small scrap, powders; clear and colours. Box 9024, care of "Plastics." 131-5305

Moulding powders. If you have any redundant stocks for disposal contact us and also give us your inquiries if you are in need of supplies of other powders. Box 9756, care of "Plastics." 131-5304

Body for ceramics, floorings, modelling, refractories, etc. Suppliers, Dohm, Ltd., 167 Victoria Street, London, S.W.1. 133-4969

Black cellulose acetate, 52 ins. by 24 ins. by .06 in. thick, 2,000 sheets available, semi-polished, first-class condition. Specification DTD 315. Immediate delivery. Box PP 14552, Samson Clarks, 57-61 Mortimer Street, W.1. 130-5307

MOON AIRCRAFT, LTD.,
SPECIALISTS IN MANIPULATED AND FABRICATED WORK.
OFFICIAL I.C.I. STOCKISTS FOR PERSPEX.
Have available from stock all thicknesses in clear and colour flat sheet cut to customers' sizes.
Inquiries, prices and particulars upon application to
CLIFT WORKS, BOX, WILTS.
Phone, Box 188.
London Office:
GROSVENOR GARDENS HOUSE, S.W.1.
Phone, Victoria 9182-3. 132-4266

Perspex I.C.I. acrylic sheeting. Official stockists offer services which include cutting to size, edge polishing and tinting; also Crinothene for lampshades, handbags, etc. Stock and price lists from Almex, Ltd., 78 Exchange Buildings, Birmingham, 2. 139-4971

Catalin beads, ½ in. square. Very good assortment in many attractive colours. Write, Box 2793, care of "Plastics." 130-1

Cellulose acetate, 30/000 in., opaque, pink, and other pastel shades. Box 2670, care of "Plastics." 130-18

Raw Material Available and Wanted (contd.)

Plastic marking tapes for tennis courts. Well-known tennis court maker wishes quotations and samples from manufacturers. Write, "A.B.E.," care of Dixons, 43 Great Marlborough Street, London, W.1. 130-15

Alumin.um sheets, alloy mouldings, corrugated dural sheets, corrugated Perspex roof lights, flat Perspex, galvanized gutters. List free. Henry Moat and Son, Ltd., Atom Works, Newcastle. 130-2

Polythene powder, white, for disposal, 10 cwt. acetate moulding powder for disposal, 1 ton; and Alkathene film, 3⅝ ins. wide, 4 mils thick, 9 cwt. Samples supplied upon request. Apply, L. Lipton, Phoenix Works, Lamprell Street, Bow, E.3. 130-9

Large quantities of clean polythene, white, black and other colours, segregated. Box 2028, care of "Plastics." zzz-202

For sale, 1,700 sheets, 6 ft. by 2 ft. by 18G; 1,600 sheets, 6 ft. by 3 ft. by 18G, half hard aluminium with light cross hatched impression; also 1,700 ft. 24 ins. wide 20G hard temper aluminium coil, all at 1s. 6d. per lb. Applications invited to Hunting Aviation, Ltd., Caernarvon, North Wales. 130-16

Cellulose acetate sheeting, clear and coloured, various thicknesses. Box 2669, care of "Plastics." 130-19

A large quantity of cellulose acetate, polythene and polystyrene scrap for sale. Box 2665, care of "Plastics." 130-22

For sale, 5 tons clean acrylic moulding powder, 1s. per lb. Box 2672, care of "Plastics." 130-25

Always large stocks of
CASEIN
rods, tubes and sheets
PERSPEX
sheets up to 1 in. thick.
CELLULOSE ACETATE.
S. Rosenfeld.
93, Aldersgate Street, E.C.1.
Phone, Clerkenwell 4686. 132-4019

D. H. Ridout and Son, Ltd., Reg. Office, 12 Stedman Road, Southbourne, Bournemouth. Phone, Southbourne 505. Offer:—
New Perspex sheet, 72 ins. by 24 ins. by 5/32 in., paper covered, 66s. sheet. 50 ins. by 12 ins. by 5/32 in., 24s. sheet.
Perspex scrap, crystal and amber, all gauges, good-sized pieces, 1s. 3d. to 2s., according to gauge, size and quantity required.
Ribbed plastic belting, 1¼ ins. wide, green and beige, 6d. per yd.
Plastic panelling in sheets, 96 ins. by 48 ins. by 1/16 in. or 1/8 in., suitable for caravans or partitions, from 45s. sheet.
Transparent acetate sheeting, .007 in. thick, 3s. 6d. lb., same material, .010 in., 4s. lb.
Opaque tangerine acetate sheets, 48 ins. by 21 ins. by 2 mm., new material, paper interleaved, 25s. sheet.
Clear emerald acetate sheet, 50 ins. by 20 ins. by ⅛ in., new material, paper interleaved, 35s. sheet.
Plastic door furniture, complete with locks, at keen prices.
2-mm. acetate sheets, slightly curved, new, interleaved, 4s. 6d. lb.
Numerous crystal and amber squares and discs, suitable for pocket torches, toys, etc. All new material. 3s. lb. Samples on request. 130-4

Ebonite and bakelite always in stock. Phone, Archway 3654. A. E. Goodeve, Ltd., 188a Seven Sisters Road, London, N.7. 139-4965

Metal powders and oxides. Quotations and samples on application. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-410

Regular supplies of imported phenolic and urea powders, polystyrene and cellulose acetate injection powders. Inquiries, Box 1211, care of "Plastics." zzz-454

Regular supplies of imported celluloid and cellulose acetate sheets, tubes and rods. Inquiries, Box 1212, care of "Plastics." zzz-455

Scrap. Why not let a well-established firm quote you for cellulose acetate, polystyrene, P.V.C. cuttings and other thermoplastic off-cuts and scrap? Having best use for these materials, highest prices can be paid. Quotations on receipt of representative samples to M. H. Grist (Plastics), Ltd., 82-84 Brighton Road, Surbiton, Surrey. Phone, Elmbridge 4214. zzz-457

P.V.C. strippings from cables, thoroughly cleaned, black, brown, red, yellow, blue, etc. Segregated. Large quantities, 1s. 3d. lb.
John Walton and Co. (Castleside), Ltd., Metalex Works, Gt. Cambridge Road, Enfield. Phone, Enfield 3425. zzz-458

Raw Material Available and Wanted (contd.)

Transparent packaging of all types; lipstick refill containers, ex stock. Modern Plastics, Ltd., Kangley Bridge Road, S.E.26. 131-5303

Wanted, plastic waste and plastic piece goods. Send particulars, stating quantity and price. Box 2382, care of "Plastics." zzz-468

Moulded plastic trays, blue and cream, 4,000 available, sizes 15 by 10 and 17 by 11½, designed if required, for clearance in one lot. Box 2515, care of "Plastics." 130-42

Wanted, thermoplastic moulding powders and moulding scraps, all kinds. Offers and samples to Alfa Plastics, Ltd., 20-21 St. Dunstan's Hill, E.C.3. 130-40

Transparent wrapping film wanted, sheets 10-in. by 8-in. upwards, or reels 4-in. upwards, any quantity, for cash, send sample and details. Allans, 37 Farringdon Street, E.C.4. Central 5947. 135-5697

SITUATIONS VACANT

None of the vacancies in these columns relates to a man between the ages of 18 and 50, inclusive, or a woman between the ages of 18 and 40, inclusive, unless he or she is excepted from the provisions of the Control of Engagement Order, 1947, or the vacancy is for employment excepted from the provisions of that Order.

A works manager wanted for a well-established Midlands company of 120 employees Applicants must be experienced on compression, transfer and injection moulding, and capable of taking responsibility for factory generally. Man with executive experience preferred, but any applicants with necessary production, technical and engineering qualifications would be considered. Give full details of experience and salary required. Box 2676, care of "Plastics." 130-28

A vacancy for a senior draughtsman will shortly occur in a well-established Midlands company of 120 employees. Applicants must have good experience of tools for compression, transfer and injection, and a good working knowledge of mould making. Man with executive experience preferred, but any applicants with necessary qualifications would be considered. Give full details of experience and salary required. Box 2675, care of "Plastics." 130-29

Sales manager required by synthetic resin adhesive manufacturers. Reply with full particulars of experience and knowledge of the trade, together with salary required, to Box 2674, care of "Plastics." 130-27

Foreman wanted for Perspex manipulating, must be toolmaker by profession and conversant with all methods of fabricating Perspex and other similar materials. Box 2673, care of "Plastics. 130-26

Monsanto Chemicals, Ltd., have vacancies in the rubber and plastics technology group of their research department at Ruabon. Preference will be given to applicants with experience in natural and synthetic latices and in problems of adhesion both in the rubber and synthetic resin field. Salaries will be between £400 and £700, according to qualifications. Apply with full particulars of age, experience, qualifications, etc., to the Director of Research and Development, Monsanto Chemicals, Ltd., Ruabon, Wrexham, N. Wales. 130-14

Wanted by progressive plastics firm junior estimator experienced in estimating for moulded and fabricated products in various plastic materials. Please apply in writing to Lacrinoid Products, Ltd., Gidea Park, Essex, stating experience and salary required, application should be endorsed "Junior Estimator." 130-12

Wanted by progressive plastics firm assistant production controller with experience in modern methods of production records and control. Please apply in writing to Lacrinoid Products, Ltd., Gidea Park, Essex, stating experience and salary required, application should be endorsed "Assistant Production Controller." 130-13

Murphy Radio require an industrial designer for radio cabinet design and associated work.
Applicants must have contemporary visual sense of a high order which they are competent to apply to the present-day trends of manufacturing and selling. Age over 24 years. Either sex. Salary £500 to £650 with good prospects. Owing to housing difficulties people living within 15 miles of Welwyn Garden City are preferable.
Two assistants are also required for work in the same department and in general should conform to the above requirements but will not be expected to have had the same degree of experience. Personnel Manager, Murphy Radio, Ltd., Welwyn Garden City, Herts. 130-11

Situations Vacant (contd.)

Sales representative required by manufacturers of modern adhesives. Preference given to candidate with experience and good connections in the woodworking industries. Reply with full particulars and salary required, etc., to Box 2678, care of "Plastics." 130-8

Rubber and plastic manufacturers require Northern area sales manager. Knowledge of P.V.C. sheeting and/or general rubber goods necessary. Connection with Northern trade useful. Reply giving full details of experience to Box 2679, care of "Plastics." 130-7

Technical representative to a large firm of thermoplastic moulding powder manufacturers required. Applicants must have good knowledge of injection moulding and moulding powder production. Good permanent position with superannuation. Applicants should send full details of qualifications and experience. Box 2589, care of "Plastics." 130-x5513

SITUATIONS WANTED

Moulding shop foreman seeks similar position, 14 years' experience, N.W. London preferred. Box 2742, care of "Plastics." 130-x5906

Chargehand, injection, wide practical experience in precision moulding with most kinds of thermo-plastics, knowledge of tools, engineering materials and holder of plastics certificate, desires progressive position. Box 2721, care of "Plastics." 130-x5857

Hons. chemistry graduate, 23, no experience plastics, seeks employment in plastics industry. Box 2720, care of "Plastics." 130-x5858

TIME RECORDERS

Factory time recorders. Service rental. Phone, Hop 2239. Time Recorder Supply and Maintenance Co., 157-159 Borough High Street, S.E.1. 137-3686

WANTED

Film spools for roll films required in 50,000 lots; also hire of moulding tools. S.L.P.P., 28 Upper Green East, Mitcham. Phone, Mitcham 4296. 131-x4912

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Extend Your Trade.
Use a Trade Mark. Consult
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12 Church Street, Liverpool. 130-9745

Photography by Behr will show your product at its best. Ask for illustrated list. 44 Temple Fortune Lane, London, N.W.11. Speedwell 4298. zzz-436

Packing Cases for Export, etc. Full service, prompt deliveries. F. Rawle and Co., Ltd., 71 Kensington Avenue, London, E.12. Phone, Grangewood 2003. 132-4010

One-gallon round tins, new, five-gallon square lever lid tins, new, and bottles for all purposes. Inquiries Box 1899, care of "Plastics." 130-x3589

For sale, bottles, tins, drums, barrels and containers of all descriptions. If you have any difficulty with your container supplies contact Box 1841, care of "Plastics." 130-x3472

Monomarks. Permanent London address. Letters redirected, 5s. p.a. Write, Monomarks, BCM/MONO76, W.C.1. 134-5313

Plastic cement for use with Perspex Acrylic sheets. Grade I, available in large or small quantities, clear and coloured. Trade inquiries from Evolite Plastics, Ltd., 325 Latimer Road, London, W.10. Phone, Lad 1879. 138-04011

One-gallon tins, new, bottles and containers for all trades. If you have any difficulty with your container supplies contact Box 2702, care of "Plastics." 132-x5798

Free-lance designer of publicity material offers services to manufacturers, Press advertising, brochures, showcards, etc. Box P.P. 15522, Samson Clarks, 57-61 Mortimer Street, London, W.1. 130-17

Immediate disposal, 2,000 high-quality stout brown-paper covered and lined cardboard boxes, 25 ins. by 3½ ins. by 3½ ins., 1s. each, discounts on 500 lots. Offers for lot invited. Box 2824, care of "Plastics." 130-x6103

Silk screen printing, articles of interest to buyers, users and printers appear monthly in "British and Colonial Printer." Write, Stonhill and Gillis, Publishers, 329 High Holborn, W.C.1. 130-x5433

Process for metallizing and mirroring gelatine foils to sell, excellent opportunity. Box 2578, care of "Plastics." 130-x5432

Engraved name plates, scales, dials, etc., supplied. Tickets and Co., Box 2, Silver Street, Leicester. 141-5699

Huts, Nissen-type, 24 ft. span and 16 ft. span, any length; also other industrial buildings, suitable for workshops, stores, garages, canteens, site offices, club halls, etc.; no acquisition licence required. Write, phone or call for details. J. Thorn and Sons, Ltd., Box 138, Brampton Road, Bexleyheath, Kent. Phone, Bexleyheath 305. zzz-204

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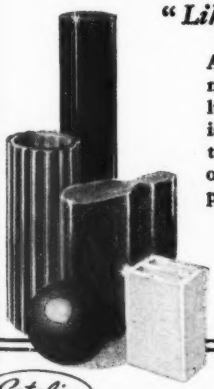

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